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BIOLOGICAL SCIENCES

THE IMPACT OF RELATIONSHIPS BETWEEN FUNGI AND PLANTS ON THE PHOTOSYNTHESIS PROCESS

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Abstract

This review systematically analyzes the mechanisms through which fungi affect key physiological processes in plant organisms. Plant–fungus interactions play roles in photosynthesis, nutrient acquisition, hormonal regulation, and stress adaptation, both in pathogenic and symbiotic contexts. Negative effects induced by pathogenic fungi are associated with tissue destruction, disruption of water and mineral balance, mycotoxin production, and increased oxidative stress. In particular, species belonging to the genera *Alternaria*, *Fusarium*, *Phytophthora*, and *Aspergillus* affect photosystem II activity, damage chloroplast structures, and promote the accumulation of reactive oxygen species, resulting in reduced photosynthetic productivity, which represents a central pathophysiological mechanism.

At the same time, the positive functional roles of fungi are indispensable. Arbuscular mycorrhizal fungi have been shown to enhance nutrient uptake, increase photosynthetic rates, and improve plant tolerance to abiotic stresses such as drought and salinity, as reported in numerous studies. The participation of saprotrophic and symbiotic fungi in carbon and nitrogen cycling, stabilization of organic matter in soils, and bioremediation processes is recognized as a key factor for ecosystem sustainability. The sink effect generated by fungi is described as an important ecological mechanism that promotes the sequestration of carbon in soils.

In conclusion, a comprehensive understanding of plant–fungus interactions provides a scientific basis for optimizing agricultural systems, maintaining soil health, and promoting sustainable ecosystem management.

Keywords: fungi, plant–fungus interactions, photosynthesis, mycorrhizal fungi, saprotrophic fungi, oxidative stress, nutrient uptake, carbon cycling

The effects of fungi on plant organisms can be manifested in various ways. These effects may be either beneficial or harmful and depend on the fungal species, their mode of distribution, and the nature of their interaction with the host plant (Smith & Read, 2008).

Fungi can influence physiological processes in plants through various mechanisms. These effects include both negative impacts that impair plant health and positive effects that support growth and development (Agrios, 2005). The influence of fungi may vary depending on the context. In agriculture, fungicides are commonly used to prevent negative effects, whereas the application of mycorrhizal fungi is widely practiced to benefit from their positive effects. The study and management of fungi are of great importance for sustainable development in ecosystems and the agricultural sector.

Negative effects may manifest through parasitism, mycotoxin production, infection, and modes of dissemination. For example, parasitic fungi such as *Alternaria*, *Erysiphe*, *Puccinia*, and *Phytophthora* cause diseases including powdery mildew, rust, and root rot, respectively, leading to damage of plant tissues. These pathogens induce necrosis and lesion formation on leaves, reduce the functional leaf surface area, destroy tissues, and consequently decrease the photosynthetic capacity of plants. At the same time, they limit oxygen availability within plant tissues and weaken energy production. Species of *Fusarium* spp. and fungi belonging to the genus *Phytophthora* damage plant roots, impair water uptake by the roots, disrupt water balance, and ultimately cause wilting (Strange & Scott, 2005). Some fungi disrupt hormonal balance in plants through the secretion of hormones and toxins. Gibberellins produced by fungi of the genus *Gibberella* induce abnormal growth of plant tissues (Taiz et al., 2015). In addition, toxins produced by fungi belonging to the genus *Alternaria* increase the levels of abscisic acid, leading to premature leaf senescence and abscission (Walters et al., 2013).

The beneficial effects of fungi on plant organisms have also been extensively studied. Mycorrhiza-forming and symbiotic fungi stimulate the uptake of nitrogen, phosphorus, water, and other mineral nutrients from the soil by plant roots. For example, *Glomus* spp. colonize plant roots and enhance the absorption of phosphorus, nitrogen, and other essential minerals. This process strengthens the supply of nutrients required for photosynthesis and other metabolic processes in plants. (Bonfante & Genre, 2010). Beneficial fungi stimulate the production of plant hormones, such as auxins and cytokinins, thereby promoting root and shoot growth (Lugtenberg & Kamilova, 2009). In addition, fungi decompose dead plant and animal residues, enriching the soil with nutrients that are readily available for plant uptake. Fungi also play an important role in protecting plants against harmful microorganisms. For example, fungi of the genus *Trichoderma* protect plant roots from pathogenic bacteria. Species such as *Trichoderma* enhance plant tolerance to both biotic and abiotic stresses (Harman et al., 2004) by activating antioxidant

defense mechanisms that protect plant cells from damaging effects. With respect to specific physiological processes, fungi contribute to the nitrogen cycle by enhancing the development of plant root systems and play a crucial role in the carbon cycle by facilitating the transfer of carbon between plants and soil. Mycorrhizal fungi increase the effective root surface area, thereby improving plant tolerance to drought conditions.

Photosynthesis is one of the most critical physiological processes in plants. Throughout their life cycle, green plants perform photosynthesis, which not only drives assimilatory processes but also regulates environmental oxygen and carbon dioxide balance. Naturally, the diverse interactions between plants and fungi significantly influence the efficiency and regulation of photosynthetic processes. The effects of fungi, particularly arbuscular mycorrhizal fungi (AMF), on plant photosynthesis have been extensively studied. These fungi establish symbiotic relationships with plants, enhancing nutrient acquisition through the roots and concurrently influencing photosynthetic processes. AMF have been shown to increase the rate of photosynthesis in host plants, facilitating greater carbon dioxide assimilation and higher energy production. This enhancement is generally associated with improved availability of nutrients such as phosphorus and nitrogen, which in turn elevates chlorophyll content and the activity of photosynthetic enzymes (Begum et al., 2019). AMF enhance plant tolerance to abiotic stresses such as drought, salinity, and high temperatures. They also protect the photosynthetic apparatus, ensuring efficient utilization of light energy. For instance, studies have shown that AMF can mitigate damage to photosystems in plants like *Paris polyphylla* under drought conditions. By improving the uptake of essential nutrients, such as phosphorus and nitrogen, from the soil, AMF strengthen root–rhizome interactions. This process generates a "sink effect," which facilitates the translocation of photosynthates from leaves to roots. (Clemmensen et al., 2013).

The "sink effect" refers to the capacity of certain areas within an ecosystem to absorb and sequester pollutants. Fungi contribute to the sink effect both directly and indirectly. They play a crucial role in ecosystems by participating in carbon cycling and the removal of pollutants. Through the decomposition of organic matter, carbon sequestration in the soil, and interactions with plants, fungi facilitate the establishment of the sink effect. Several mechanisms by which fungi generate this sink effect have been identified. Saprotrophic fungi decompose dead organic matter, including leaves, wood debris, and animal residues, facilitating the incorporation of carbon into the soil. This process contributes to the long-term retention of organic carbon in the soil. The decomposed material is transformed into humus, creating a persistent carbon reservoir. In contrast, mycorrhizal fungi form symbiotic associations with plant roots, enhancing nutrient acquisition from the soil and promoting more efficient carbon sequestration. Plants transfer a portion of the carbon assimilated through photosynthesis to mycorrhizal fungi, which either store this carbon or release it into the soil.

Additionally, these mechanisms contribute to soil carbon stabilization, the reduction of greenhouse gases, and the bioremediation of pollutants. Enzymes secreted by fungi, such as ligninases and cellulases, break down complex organic compounds and facilitate the binding of carbon to soil particles. The decomposition of fungal structures, including hyphae, further contributes to carbon retention in the soil. Some fungi are capable of degrading or assimilating methane (CH_4) and other greenhouse gases, thereby reducing their atmospheric concentrations. Moreover, fungi help cleanse ecosystems by breaking down or sequestering pollutants in soil and water, including heavy metals, pesticides, and petroleum hydrocarbons. This process aids in the biochemical transformation of pollutants and contributes to the restoration of soil health. Nevertheless, given the diversity of plant–fungus interactions, these relationships are not without negative impacts. Studies on fungi that produce mycotoxins indicate that these compounds can interfere with photosynthesis in various ways. Certain mycotoxins, such as aflatoxins, affect pigment systems in plants by reducing chlorophyll and carotenoid synthesis, leading to symptoms such as virescence (loss of greenness) or albinism, which ultimately diminish photosynthetic efficiency.

One of the mycotoxins, cytochalasin A, impairs the activity of photosystem II (PSII) and disrupts electron transport (Chen et al., 2017). This leads to alterations in chlorophyll fluorescence and the inactivation of reaction centers within PSII. These effects are associated with the activity of mycotoxin-producing fungi, particularly species of *Aspergillus*, *Penicillium*, and *Fusarium*. Fungi of the genus *Aspergillus* produce a variety of mycotoxins, including aflatoxins, ochratoxins, and sterigmatocystin. These compounds induce oxidative stress in leaves, damaging chloroplast structures and interfering with electron transport in photosystem II (PSII), thereby reducing the conversion of light energy into chemical energy. (Reverberi et al., 2010). These effects are particularly associated with the oxidation and inactivation of proteins in PSII. *Aspergillus* toxins redirect plant resources toward defense mechanisms, thereby reducing the energy and nutrients available for photosynthesis and other metabolic processes. Mycotoxins also induce oxidative stress, increasing levels of reactive oxygen species (ROS) within cells, which damages photosynthetic enzymes and membranes. Consequently, overall photosynthetic productivity declines, impairing plant growth and development. These impacts ultimately lead to significant reductions in plant health and yield.

In summary, plant–fungus interactions exert profound influences on key physiological processes in plants, encompassing both beneficial and detrimental effects. Pathogenic fungi negatively impact plant health through tissue destruction, disruption of water and nutrient balance, mycotoxin production, and induction of oxidative stress, ultimately impairing photosynthesis and reducing growth and yield. Conversely, symbiotic fungi, particularly arbuscular mycorrhizal and

saprotrophic species, enhance nutrient uptake, stimulate photosynthesis, improve stress tolerance, and contribute to carbon and nitrogen cycling, soil stabilization, and bioremediation. The establishment of mechanisms such as the "sink effect" highlights the ecological significance of fungi in carbon sequestration and ecosystem sustainability. Understanding the complex dynamics of these interactions provides a scientific foundation for optimizing agricultural practices, promoting soil health, and implementing sustainable ecosystem management strategies. Continued research into the molecular and physiological mechanisms underlying plant–fungus interactions is essential for harnessing their positive potential while mitigating adverse effects.

References

1. Agrios, G. N. (2005). *Plant pathology* (5th ed.). Elsevier Academic Press.

2. Begum, N., Qin, C., Ahanger, M. A., Raza, S., Khan, M. I., Ashraf, M., Ahmed, N., & Zhang, L. (2019). Role of arbuscular mycorrhizal fungi in plant growth regulation: Implications in abiotic stress tolerance. *Frontiers in Plant Science, 10*, 1068.

3. Bonfante, P., & Genre, A. (2010). Mechanisms underlying beneficial plant–fungus interactions in mycorrhizal symbiosis. *Nature Communications, 1*, 48.

4. Chen, L., Zhang, J., Zhao, B., & Wang, X. (2017). Effects of fungal toxins on photosystem II activity in plants. *Plant Physiology and Biochemistry, 115*, 10–18.

5. Clemmensen, K. E., Bahr, A., Ovaskainen, O., Dahlberg, A., Ekblad, A., Wallander, H., ... & Lindahl, B. D. (2013). Roots and associated fungi drive long-term carbon sequestration in boreal forest. *Science, 339*, 1615–1618.

6. Harman, G. E., Howell, C. R., Viterbo, A., Chet, I., & Lorito, M. (2004). Trichoderma species—opportunistic, avirulent plant symbionts. *Nature Reviews Microbiology, 2*, 43–56.

7. Lugtenberg, B., & Kamilova, F. (2009). Plant-growth-promoting rhizobacteria. *Annual Review of Microbiology, 63*, 541–556.

8. Morkunas, I., Woźniak, A., Mai, V. C., Rucińska-Sobkowiak, R., & Jeandet, P. (2018). The role of oxidative stress in plant response to mycotoxins. *Plant Physiology and Biochemistry, 123*, 160–170.

9. Reverberi, M., Zjalic, S., Ricelli, A., Punelli, F., Camera, E., Fabbri, C., ... & Fanelli, C. (2010). Modulation of oxidative stress response by aflatoxin biosynthesis. *Applied Microbiology and Biotechnology, 87*, 1259–1267.

10. Ruiz-Lozano, J. M., Aroca, R., Zamarreno, A. M., Molina, S., Andreo-Jimenez, B., Porcel, R., ... & López-Ráez, J. A. (2016). Arbuscular mycorrhizal symbiosis induces systemic tolerance to drought. *New Phytologist, 211*, 1032–1048.

11. Smith, S. E., & Read, D. J. (2008). *Mycorrhizal symbiosis* (3rd ed.). Academic Press.

12. Strange, R. N., & Scott, P. R. (2005). Plant disease: A threat to global food security. *Annual Review of Phytopathology, 43*, 83–116.

13. Taiz, L., Zeiger, E., Møller, I. M., & Murphy, A. (2015). *Plant physiology and development* (6th ed.). Sinauer Associates.

14. Treseder, K. K., & Lennon, J. T. (2015). Fungal traits that drive ecosystem dynamics. *Annual Review of Ecology, Evolution, and Systematics, 46*, 327–350.

15. Walters, D., Newton, A., & Lyon, G. (2013). *Induced resistance for plant defence*. Wiley-Blackwell.

16. Wu, Q. S., & Xia, R. X. (2006). Arbuscular mycorrhizal fungi influence growth, osmotic adjustment and photosynthesis of citrus under drought stress. *Journal of Plant Physiology, 163*, 417–425.

ECONOMIC SCIENCES

STATISTICAL AND STRUCTURAL ANALYSIS OF PRICE DYNAMICS IN THE AZERBAIJAN HOUSING MARKET

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Abstract

The housing market plays a critical role in both economic and social development, influencing living standards, urbanization, investment activity, and overall economic growth. This study examines the Azerbaijani housing market over the period 2012–2025, focusing on the interaction between price dynamics, macroeconomic factors, and consumer behavior. Using quarterly housing price indices, the research identifies long-term upward trends, seasonal fluctuations, and price differentiation across various housing segments. One-room apartments demonstrate relatively stable price changes, while larger apartments exhibit higher volatility, reflecting the impact of middle- and high-income groups on market behavior. The study also highlights the importance of the housing product concept and target market identification, emphasizing that consumer decisions are influenced not only by price but also by comfort, security, infrastructure, and investment value. The findings provide a solid empirical basis for econometric modeling, supply-demand analysis, and market forecasts, contributing both to academic research and practical applications in housing market management.

Keywords: Housing market, Azerbaijan, price dynamics, consumer behavior, housing price index, market segmentation, target market, seasonal variation, macroeconomic factors, investment value

İntroduction

The housing market is one of the areas of strategic importance in the modern market economy, both economically and socially. This market plays an important role in improving the living conditions of the population, accelerating urbanization processes, expanding investment activity and ensuring overall economic growth. Structural changes, price dynamics and supply-demand relations occurring in the housing market directly affect macroeconomic stability, the financial sector and social well-being. For this reason, the scientific study of the housing market is one of the current topics in economic research.

The economic growth observed in the Azerbaijani economy over the past decades, the increase in the level of urbanization, the change in the income structure of the population and the expansion of the construction sector have had a significant impact on the development of the housing market. In particular, the introduction of mortgage mechanisms, state housing programs and the activity of private construction companies in the market have created conditions for an increase in the housing supply and the formation of the market from an institutional perspective. At the same time, the dynamic change in prices acts as a decisive factor in the formation of consumer behavior, investment decisions and market expectations.

The distinctive features of the housing market from other markets – being a long-term capital-intensive asset, strong dependence on the spatial factor, regional inequality and high investment risk – indicate that the analyses conducted in this area require a comprehensive approach. The formation of prices is closely related not only to supply and demand factors, but also to factors such as macroeconomic indicators, inflation rate, population incomes, development of financial markets and expectations. In this regard, the study of pricing mechanisms in the housing market on an empirical basis is of great scientific and practical importance.

The aim of this study is to analyze the interaction of price dynamics with key economic factors in the Azerbaijani housing market using statistical and empirical methods, to identify the structural characteristics of the market, and to assess the impact of price changes on market behavior. Within the framework of the study, housing price indices were analyzed based on quarterly statistical data covering the years 2012–2025, differences across different housing segments were examined, and seasonal characteristics of the market were identified.

The statistical analyses conducted form a solid empirical basis for econometric modeling at the next stage. This allows for a deeper explanation of the mechanisms of price formation in the housing market, measurement of the main influencing factors, and prediction of future price trends. Thus, the research results are useful both at the academic level and in the economic research methodology.

This study aims to empirically determine the mechanisms of price dynamics formation in the Azerbaijani housing market and the main economic factors influencing it. The study applied a combination of statistical and econometric methods, using both quantitative and analytical approaches. The methodological approach allows for a comprehensive assessment of the structural characteristics of the market, its variability over time, and cause-and-effect relationships.

Literature Review

The housing market has been studied as one of the main indicators of economic and social development. International and domestic studies show that the price dynamics of the housing market are closely related to a number of macroeconomic, social and financial factors. The formation of prices depends not only on supply and

demand, but also on the level of urbanization, the income structure of the population, inflation and credit mechanisms (Glaeser et al., 2013; Leishman, 2014).

Studies conducted in the context of the Azerbaijani housing market show that in recent decades, the increase in the level of urbanization, the introduction of mortgage mechanisms, the implementation of state housing programs, and the expansion of the activities of private construction companies have had a significant impact on the development of the market (Hüseynov, 2018; Mammadova, 2020). In particular, the analysis of quarterly housing price indices shows that there is a long-term upward trend in prices in the market, which can be associated with an increase in the income level of the population and changes in construction costs (State Statistical Committee of the Republic of Azerbaijan, 2025).

The issue of price differentiation by number of rooms and market segmentation also occupies a special place in the research. One-room apartments have more stable price fluctuations and are mainly intended for young families and low-income groups. Two-room apartments are considered attractive for both residential and investment buyers and are considered a balanced segment of the market. Three-room and four-room apartments, on the other hand, exhibit higher volatility during periods of economic growth, which indicates that the market behavior of middle and upper income groups has a stronger impact on price formation (Official statistical indicators, 2012–2025).

The impact of seasonal fluctuations in the housing market is also noted in studies. In the first and second quarters, price growth is more stable, while in the third quarter, in some years, a weakening of the growth rate is observed. In the fourth quarter, the increase in price indices is explained by the increase in buying and selling and investment activity towards the end of the year (Leishman, 2014; Huseynov, 2018).

In the marketing literature, the housing product is considered not only as a physical object, but also as a complex offering characterized by comfort of living, safety, socio-environment, infrastructure and investment value. This approach shows that consumers pay attention not only to price when choosing housing, but also to the total value package provided (Kotler & Keller, 2022). Correctly identifying target markets is considered a key factor for market segmentation and increasing the effectiveness of marketing strategies (Mammadova, 2020).

Thus, domestic and international literature shows that the price dynamics of the housing market are related to both macroeconomic factors and consumer behavior and market structure. Statistical and structural analyses conducted on the Azerbaijani housing market confirm these results, while also emphasizing the importance of long-term price growth trends, seasonal variability, and segmentation. In this regard, studies conducted on the basis of empirical data covering the years 2012–2025 allow for a more accurate understanding of the behavioral mechanisms of the market and the prediction of future price trends.

Database and data sources

The study used quarterly time series covering the years 2012–2025. The main variable was the housing price indices for Azerbaijan (general indicator and differentiated indices by the number of rooms). The explanatory variables included the main macroeconomic and economic indicators that affect the formation of prices in the housing market. The data were obtained mainly from the open statistical databases of the State Statistical Committee of the Republic of Azerbaijan, the Central Bank and relevant official agencies. The selection of quarterly data allows for more accurate observation of short-term fluctuations and seasonal effects in the market.

The housing market is one of the most dynamic and socially sensitive sectors of the market economy and is closely related to the country's economic development, the well-being of the population and the processes of urbanization. Privatization, regulation of land relations, the development of mortgage mechanisms and the expansion of the construction sector are the main economic factors shaping the structure of the housing market. Price fluctuations, supply and demand balance and investment attractiveness in this market directly affect both the value of property and economic stability.

The housing market has specific characteristics: being a long-term asset requiring high capitalization, strong dependence on space and infrastructure, and uneven development across regions. Therefore, the economic approach to the housing market is closely related to its regulation, management, and ensuring its efficient use.

Housing market management is a complex system of measures aimed at increasing the value, profitability and efficiency of use of residential space in accordance with the interests of the owner. This process is the main mechanism that ensures both the quality of the housing stock and the sustainability of the market. The management activities in the housing market are as follows:

1. Development of programs for more efficient use of the housing stock.
2. Design work on residential buildings and their infrastructure.
3. Investment in the construction and renovation of apartments.
4. Construction, installation and improvement of new residential complexes.
5. Assessment of the market value of housing facilities.
6. Developing marketing strategies appropriate for the housing market.
7. Purchase, sale, rental, mortgage and other transactions of apartments.
8. Service and maintenance services of residential buildings.
9. Technical maintenance, current and emergency repairs.
10. Major repairs, modernization and reconstruction of buildings.
11. Changing the functional purpose of housing facilities.

12. Demolition of residential buildings that have reached the end of their useful life and reuse of the areas.

The effects of price changes on consumer behavior.

The formation of prices in the housing market changes dynamically over time, and these changes act as a key factor affecting consumer behavior. For example, according to official statistics, in the 1st quarter of 2025, prices in the primary market increased by an average of 12.9%, and in the secondary market by 14.4%, and in the 3rd quarter, the price index in the housing market in Azerbaijan increased by 101.6% compared to the previous quarter. This increase was observed both in the primary market and in the secondary market. The continuous increase in prices is also evident from monthly and quarterly statistical indicators. For example, in certain periods, the general price level in the housing market increases compared to the previous period, indicating a steady increase in the price dynamics of the market. This upward trend can change both purchasing decisions and market behavior for consumers. Rising prices, especially the differences between new buildings and old buildings, affect the population's choice of housing - selling square meters in new buildings at higher prices can change the market segment of selected apartments. Such factors play an important role in the analysis of behavioral patterns in the housing market, and scientific research conducted in this area specifically considers the impact of price dynamics on consumer choices.

Product concept and target market identification in the housing market

In marketing theory, the concept of "product" is not limited to a material object, but is considered a set of values and benefits offered to the consumer. When this approach is applied to the real estate market, the housing product is not just a living space, but also a complex offer characterized by comfort, security, social environment, infrastructure opportunities and long-term investment value. It is precisely these features that determine the formation of the concept of product in the housing market in a different way from other market segments.

The three-level product model, widely used in marketing literature, is also applied to the housing market. According to this model, the main product is the housing that meets the living needs. At the real product stage, the area, planning, quality of construction materials, location and technical indicators of the apartment come to the fore. The extended product, on the other hand, includes added values such as security systems, parking facilities, landscaping, transport accessibility, social and commercial infrastructure, as well as after-sales services. This approach shows that consumers pay attention not only to the price factor when choosing a housing, but also to the total value package provided.

The correct formulation of the product concept in the housing market requires the precise identification of target markets. The target market refers to the consumer group to which a certain product or service is directed and forms the basis of the marketing strategy. According to marketing theory, the identification of target markets begins with market segmentation. Segmentation aims to divide consumers into groups with similar characteristics and assess the needs of each group separately.

In the real estate market, demographic, economic and social criteria are mainly applied in determining target markets. Income level, family composition, age group, lifestyle and investment purpose are among the main factors determining consumer behavior in the housing market. For example, while affordable prices and infrastructure are considered the main priorities for middle-income families, prestigious location, security and additional services play a more important role for high-income consumers. These differences require dividing the market into different segments and formulating different product and marketing strategies for each segment. The correct selection of the target market allows construction and real estate companies to use resources efficiently and gain a competitive advantage in the market. The marketing strategy is based on product positioning, pricing policy, communication tools and sales channels in accordance with the needs of the target audience. In this regard, in the housing market, the concept of product and the concept of target market are closely interconnected and act as strategic elements that complement each other.

Thus, the complex nature of the product concept in the housing market and the application of a consumer-oriented approach necessitate the scientific identification of target markets. This approach allows for a more accurate assessment of market demand and increases the effectiveness of marketing strategies.

Analysis of quarterly housing price indices covering the years 2012–2025 shows that the Azerbaijani housing market has demonstrated a long-term upward trend. The fact that the indices for the indicator "Residential houses – total" are above 100 units in most cases confirms that prices have increased compared to the base period. In particular, price growth has intensified in 2014–2015, as well as in 2022–2025. Although a relative slowdown in the rate of price growth was recorded in 2020 due to the pandemic, this decline was short-lived and the market recovered rapidly in subsequent periods.

Seasonal variation by quarter

Analysis of quarterly data shows that seasonal factors play a significant role in the housing market:

- **In the first and second quarters**price increases are more stable and measured;
- **In the third quarter**in some years, price increases weaken or fluctuate around 100 units;
- **In the fourth quarter**In most cases, price indices increase, which can be explained by increased investment and buying and selling activity towards the end of the year.

This trend is observed across all housing categories and confirms the seasonal structure of the market.

3. Differential analysis by number of rooms

One-room apartments

Price indices for one-room apartments show relatively low volatility compared to other categories.

The fact that the main demand for this type of apartment is formed by young families, students and low-income groups of the population leads to more stable prices. At the same time, in the long term, this segment is also experiencing steady growth.

Two-room apartments

Two-bedroom apartments are considered one of the most balanced segments of the market. Price indices show a stable increase both quarter-on-quarter and quarter-on-quarter. Since this category is attractive to both residential and investment buyers, sustained demand is driving up prices.

Three-room apartments

Price indices for three-room apartments have higher volatility. Price increases in this segment accelerate, especially during periods of economic growth. This fact indicates that the market behavior of middle and upper income groups has a stronger impact on price formation.

Four-room apartments

Price indices for four-room apartments demonstrate the highest level of volatility of all time. Prices in this segment are more sensitive to macroeconomic expectations, inflation levels and investment risks. Sharp price increases were observed in this category in 2015, 2017 and 2023–2025.

4. Short-term fluctuations and market stability

The fact that the indices fluctuated mainly in the range of 98–103 compared to the previous quarter indicates that there are no sharp price shocks in the housing market. This is an important indicator that the market is institutionally formed and that pricing mechanisms are operating relatively stably.

5. Economic interpretation of statistical results

The statistical analysis shows that the formation of prices in the Azerbaijani housing market is explained by the following main factors:

- long-term economic growth and urbanization processes;
- changes in the income level of the population;
- rising construction costs and inflationary pressures;
- expansion of mortgages and financial instruments;
- increasing interest in real estate for investment purposes.

These indicators confirm that the housing market is not only a social, but also a macroeconomic and investment-oriented sector. Analysis of quarterly statistical data for 2012–2025 shows that the Azerbaijani housing market has expanded structurally, and price growth has become sustainable in the long term. As the number of rooms increases, price volatility increases, which indicates the presence of segmentation in the market. The results obtained create a solid empirical basis for econometric modeling, supply-demand analysis, and consumer behavior assessment at the next stage.

The extensive statistical and structural analysis conducted in the previous chapters has shown that the Azerbaijani housing market has undergone significant changes over the period 2012–2025. House price indices calculated on the basis of quarterly data reveal the existence of continuous growth trends in the market, while at the same time short-term fluctuations and cyclical volatility play a significant role.

Conclusion

The conducted statistical and structural analysis shows that the Azerbaijani housing market has demonstrated a long-term growth trend and has expanded structurally over the period 2012–2025. Price volatility increases with the number of rooms, which indicates that the market is segmented.

Analysis of quarterly data reveals the impact of seasonal factors on market behavior: price growth is stable in quarters I and II, growth weakens in some years in quarter III, and prices rise in quarter IV with increased buying and selling activity towards the end of the year.

Price increases change consumer behavior, especially the differences between new buildings and old buildings shape choice tendencies. From a marketing perspective, the housing product is evaluated not only as a living space, but also as a complex offer characterized by social and investment value. Correctly defining target markets allows for a more accurate assessment of consumer behavior and market demand.

Overall, the results obtained show that price formation in the Azerbaijani housing market is determined by the interaction of macroeconomic factors, investment interests, and consumer behavior. This analysis creates a solid empirical basis for econometric modeling, supply-demand analysis, and market forecasts in the next stage.

References

1. State Statistical Committee of the Republic of Azerbaijan. (2025). Housing market statistics. Baku.

2. Glaeser, E., Gyourko, J., & Saiz, A. (2013). Housing supply and housing bubbles. Journal of Urban Economics, 64(2), 198–217.

3. Huseynov, R. (2018). Price dynamics and demand structure in the Azerbaijani housing market. Baku: Elm Publishing House.

4. Sara M. Huseynova, & Telman J. Hajizada (2024). Analysis of the Stability of the Banking Sector of Azerbaijan in Conditions of Economic Crisıs Based on the Econometric Model. Статистика и экономика, 21 (2), 35-49. doi: 10.21686/2500-3925-2024-2-35-49

5. Huseynova, S., & Balajayeva, L. (2025). Digital Banking Regulation in Azerbaijan: Empirical Insights into User Trust, Risk Management, and Data Protection. *Journal of Eastern European and Central Asian Research (JEECAR)*, *12*(2), 80–97. https://doi.org/10.15549/jeecar.v12i2.2153

6. SM, H., & SS, R. (2025). Empirical Investigation of the Relationship Between the Tourism Sector and Economic Growth: Case of Azerbaijan. *Problems of Economy*, *64*(2).

7. Sara, H., & Nurlana, T. (2024). STATISTICAL ANALYSES OF THE ATTITUDE OF INTERESTED PARTIES TO MARKETING STRATEGIES OF AZERBAIJAN UNIVERSITIES. *Revista de Gestão Social e Ambiental*, *18*(11), 1-20.

8. Kotler, P., & Keller, KL (2022). Marketing Management (16th ed.). Pearson.

9. Leishman, C. (2014). Housing markets and economic cycles. Urban Studies, 51(7), 1403–1421.

10. Mammadova, S. (2020). Economic and social aspects of the housing market. Baku: Educational Publishing House.

THEORETICAL FOUNDATIONS OF ARTIFICIAL INTELLIGENCE APPLICATION IN THE "SAFE CITY" SYSTEM

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Abstract
This article explores the theoretical foundations of integrating artificial intelligence (AI) into the Safe City system. Key approaches to using AI to improve urban safety are examined, including monitoring, threat prediction, emergency management, and optimization of response resources. International experience in integrating AI into urban security systems is analyzed, identifying the advantages and limitations of such solutions. The role of theoretical models, machine learning algorithms, and big data analytics as the foundation for the functioning of smart city systems is emphasized.

Keywords: Artificial intelligence, smart city, Safe City system, machine learning, big data analytics, predictive security, video analytics.

1. Introduction.

Modern cities face a growing number of threats: crime, emergencies, and natural and man-made disasters. Traditional security methods often struggle to cope with the volume of information and response time. In these circumstances, artificial intelligence (AI) technologies are becoming a key tool for automating threat monitoring, analysis, and prediction, forming the foundation of the "Safe City" system.

The Safe City system involves integrating digital technologies, video surveillance, data analytics, and AI to improve the efficiency of security services and citizen protection. It is important to theoretically justify the use of AI to develop optimal algorithms for analyzing and responding to events.

2. Theoretical aspects of the research.

Artificial intelligence (AI) is an interdisciplinary field of scientific knowledge that combines computer science, mathematics, cognitive science, economics and management, aimed at developing intelligent systems capable of performing functions that traditionally require human thinking[1].

The authors of Wolniak & Stecuła note that artificial intelligence in smart cities is used not only for traffic analysis and infrastructure management, but also for predicting threats and optimizing security service resources[2]. Authors Ahmed et al. note that machine learning and AI algorithms can detect anomalies and potential threats in urban environments, which improves the effectiveness of security services[3].

Researchers Ullah et al. note that large language models (LLMs) and deep learning make it possible to analyze huge volumes of unstructured data, improving event forecasting and decision-making in smart cities[4].

The authors, Xu et al., note in their work that the use of generative AI and digital twins of cities makes it possible to create simulations of urban infrastructure and predict emergency situations or system overloads[5].

Szpilko et al. also note that AI in smart cities is integrated into all key areas: mobility, energy, ecology, and social services, while its implementation requires consideration of ethical and legal standards[6]. Mohammadi & Al-Fuqaha note that cognitive smart cities are built on the basis of adaptive machine learning and big data analysis, which allows AI systems to learn and improve as they interact with urban infrastructure[7].

It should be noted that the functions of artificial intelligence include information analysis, learning, decision making, forecasting and adaptation to changing conditions[8]. From a theoretical perspective, AI is viewed as a set of algorithms and models that imitate human cognitive processes based on formalized rules and statistical methods.

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[1]Russell S., Norvig P. Artificial Intelligence: A Modern Approach. Pearson, 2021.

[2]Wolniak, R. & Stecuła, K. Artificial Intelligence in Smart Cities—Applications, Barriers, and Future Directions: A Review. Smart Cities, 2024, 7(3), 1346–1389. DOI:10.3390/smartcities7030057.

[3]Ahmed, S., Hossain, M.F., Kaiser, MS, Noor, M.B.T., Mahmud, M.R. & Chakraborty, C. Artificial Intelligence and Machine Learning for Ensuring Security in Smart Cities. Advanced Sciences and Technologies for Security Applications, 2021, pp.23–47. DOI:10.1007/978-3-030-72139-8_2.

[4]Ullah, A., Qi, G., Hussain, S., Ullah, I., & Ali, Z. The Role of LLMs in Sustainable Smart Cities: Applications, Challenges, and Future Directions. arXiv, 2024.

[5]Xu, H., Omitaomu, F., Sabri, S., Zlatanova, S., Li, X., & Song, Y. Leveraging Generative AI for Urban Digital Twins. arXiv, 2024.

[6]Szpilko, D., Jimenez Naharro, F., Lăzăroiu, G., Nica, E., & de la Torre Gallegos, A. Artificial Intelligence in the Smart City - A Literature Review. Engineering Management in Production and Services, 2023, 15(4).

[7]Mohammadi, M., & Al-Fuqaha, A. Enabling Cognitive Smart Cities Using Big Data and Machine Learning: Approaches and Challenges. arXiv, 2018.

[8]Wooldridge M. An Introduction to MultiAgent Systems. Wiley, 2020.

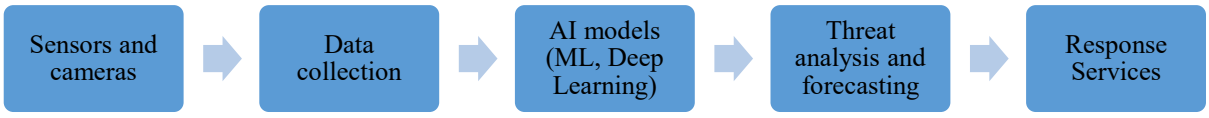

Figure 1. Theoretical model of AI application in the Safe City system[9]

Furthermore, the use of AI in the Safe City system is based on the following theoretical principles:

1. Machine learning (ML) is the use of algorithms to classify and predict events based on historical data.
2. Deep Learning - neural networks for processing complex data such as video and audio streams, face and object recognition.
3. Computer Vision - recognition of objects, faces, and abnormal situations in urban video data streams.
4. Big Data Analytics is the collection and processing of large volumes of information to identify patterns and predict threats.
5. Predictive analytics is the use of AI algorithms to assess the likelihood of incidents and prevent threats.

Key applications of artificial intelligence in urban security include automated monitoring of video and sensor data for the timely detection of anomalies and potential threats. AI is used to predict criminal activity, accidents, and emergencies to optimize emergency response.

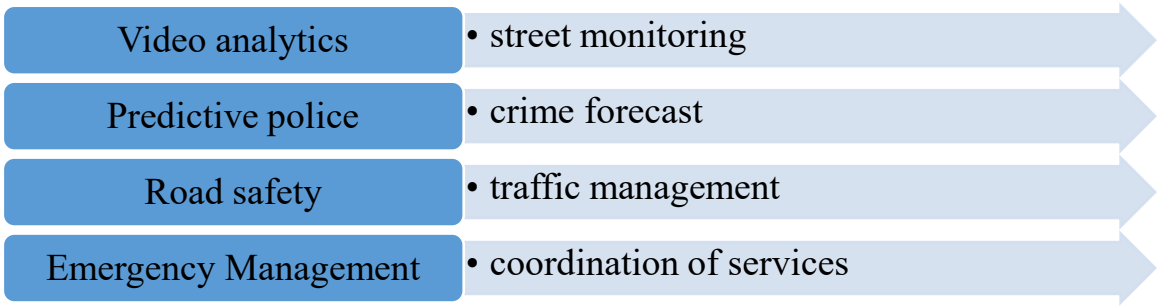

Figure 2. Main areas of AI application in urban security10

In addition, intelligent algorithms help allocate police, ambulance, and response services resources, improving the efficiency of urban infrastructure and security management.

Theoretical models include a multi-layered smart city architecture, where data from sensors, cameras, and sensors is transmitted to central analytical systems, processed by AI, and generates recommendations for emergency services.

3. Methodological aspects of the research.

The study's methodological framework includes a systemic analysis of existing theoretical models for applying AI in cities, a comparative analysis of international Safe City implementation practices, a content analysis of publications on machine learning and big data analytics for security, and AI-based threat scenario modeling to assess system effectiveness. These analytical methods allow us to identify optimal AI integration algorithms and evaluate the effectiveness of forecasting and automated response processes.

4. International experience of the research.

The United States is a global leader in the development and implementation of artificial intelligence. Government policy is focused on stimulating private investment, developing venture capital, and supporting scientific research. AI is widely used in the financial sector, defense, healthcare, and digital platforms. Universities and research centers play a significant role in ensuring technology transfer to the real economy.

China is implementing a state-centric model of AI development, viewing it as a strategic resource for national competitiveness. The primary focus is on large-scale digitalization of industry, the use of big data, and the integration of AI into public administration. Significant public investment is enabling China to accelerate the development of intelligent technologies and integrate them into key economic sectors.

Germany is applying AI primarily in the industrial sector as part of the "Industry 4.0" concept. The focus is on intelligent manufacturing, process automation, and energy efficiency. Government support is aimed at developing applied research, standardization, and training qualified personnel, ensuring the sustainable implementation of AI in the economy.

South Korea has demonstrated successful experience in integrating AI into high-tech industries, including electronics, telecommunications, and smart cities. The government's strategy focuses on developing digital infrastructure, supporting startups, and actively using AI in education and public administration. Significant attention is paid to developing human resources in the field of digital technologies.

France, as one of the EU's leaders in AI, is implementing a model based on a combination of

[9]Prepared by the author.
[10]Prepared by the author.

innovative development and strict ethical regulation. AI is actively used in the public sector, transportation, healthcare, and energy. The European approach is characterized by a high degree of regulatory oversight aimed at ensuring the transparency, safety, and social responsibility of AI use.

National experience demonstrates that the successful implementation of artificial intelligence requires a systemic approach, including a government strategy, investment in science and education, digital infrastructure development, and effective institutional regulation. International practice can serve as a methodological basis for developing a national AI development model, taking into account the country's socioeconomic characteristics.

5. Analysis and results.

The use of artificial intelligence technologies in the Safe City system significantly improves the efficiency of urban security management. AI enables automated processing of data from CCTV cameras and sensors, predicts potential crimes, accidents, and emergencies, accelerates emergency response, optimizes resource allocation, and improves the safety of road traffic, urban infrastructure, and public spaces. Intelligent algorithms can identify anomalies in human behavior and traffic flows, facilitating proactive incident prevention and improving service planning.

However, the implementation of AI is associated with a number of limitations and risks. One key issue is ensuring the privacy and protection of citizens' personal data, as the systems process large amounts of information, including video and sensor data. The high cost of implementing and maintaining technical infrastructure, the need for qualified AI and big data analytics specialists, and the difficulty of integrating with existing systems create additional challenges for city administrations. Furthermore, there is a risk of classification errors and false positives, which can lead to incorrect decisions by security services and a decrease in public trust in the technology.

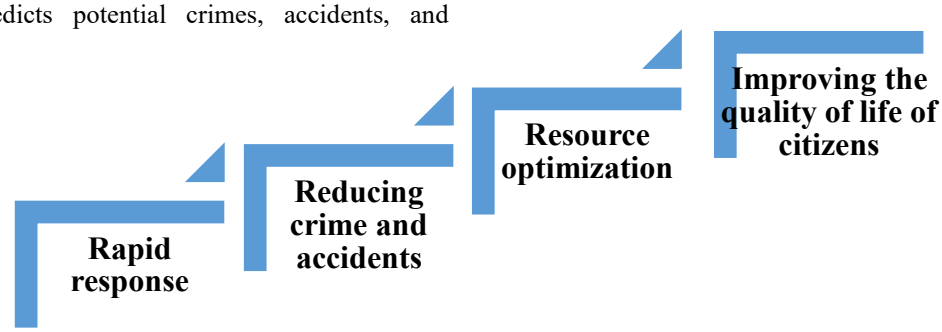

Figure 3. Benefits of integrating AI into the Safe City system[11]

To effectively and securely integrate AI into the Safe City system, it is necessary to combine technological solutions with the development of a regulatory framework, specialist training, the implementation of transparent algorithm oversight procedures, and continuous monitoring of system performance. Equally important is the creation of mechanisms for interaction between various services, ensuring the rapid exchange of data and a more coordinated response to threats. Only with a comprehensive approach is it possible to create an intelligent, reliable, and ethically sound urban security management system capable of mitigating risks, preventing incidents, and improving the quality of life for residents.

6. Conclusion.

The use of artificial intelligence in the Safe City system relies on modern theoretical models of machine learning, deep learning, and big data analytics, enabling automated monitoring, threat prediction, and optimization of emergency services. Effective implementation of AI requires the development of computing infrastructure, the training of qualified specialists, adherence to data protection principles and the ethicality of algorithms, and the integration of intelligent solutions into existing urban management systems. The comprehensive implementation of AI creates a safe, intelligent, and resilient urban space capable of promptly identifying and effectively responding to a variety of threats, improving quality of life and the sustainability of the urban environment.

References

1. Ahmed, S., Hossain, M.F., Kaiser, MS, Noor, M.B.T., Mahmud, M.R. & Chakraborty, C. Artificial Intelligence and Machine Learning for Ensuring Security in Smart Cities. Advanced Sciences and Technologies for Security Applications, 2021, pp.23–47. DOI:10.1007/978-3-030-72139-8_2.

2. Mohammadi, M., & Al-Fuqaha, A. Enabling Cognitive Smart Cities Using Big Data and Machine Learning: Approaches and Challenges. arXiv, 2018.

3. R. Szeliski. Computer Vision: Algorithms and Applications. Springer, 2019.

4. Russell S., Norvig P. Artificial Intelligence: A Modern Approach. Pearson, 2021.

5. ShotSpotter Inc. Urban Safety Technologies. 2022.

6. Smart Nation Singapore. AI for Urban Safety. Government Report, 2021.

7. Szpilko, D., Jimenez Naharro, F., Lăzăroiu, G., Nica, E., & de la Torre Gallegos, A. Artificial Intelligence in the Smart City - A Literature Review.

[11]Author's development.

Engineering Management in Production and Services, 2023, 15(4).

8. Ullah, A., Qi, G., Hussain, S., Ullah, I., & Ali, Z. The Role of LLMs in Sustainable Smart Cities: Applications, Challenges, and Future Directions. arXiv, 2024.Xu, H., Omitaomu, F., Sabri, S., Zlatanova, S., Li, X., & Song, Y. Leveraging Generative AI for Urban Digital Twins. arXiv, 2024.

9. UN-Habitat. Urban Safety and Smart Cities. UN, 2020.

10. Wolniak, R. & Stecuła, K. Artificial Intelligence in Smart Cities—Applications, Barriers, and Future Directions: A Review. Smart Cities, 2024, 7(3), 1346–1389. DOI:10.3390/smartcities7030057.

11. Wooldridge M. An Introduction to MultiAgent Systems. Wiley, 2020.

JURISPRUDENCE

EUROPEAN COURT OF HUMAN RIGHTS INDIVIDUAL MEASURES EXECUTION. CATALYZING JUDICAL REFORMS IN ALBANIA

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Abstract

This article aims to analyze the individual measures in the context of executing the European Court of Human Rights judgments, with particular emphasis on those that have shown the potential to promote legal reforms, as a result of the identification of structural problems in national legislation and practice. The article illustrates that the transformative impact of the ECtHR jurisprudence is not limited to decisions that suggest general measures, but also extends to those cases where individual measures are determined.

Within this analysis, only those decisions of the Court that are considered illustrative and significant for the purposes of the study will be brought to attention, especially those that clearly reflect an impact in the national legal order by identifying and addressing structural problems. The selection of these decisions seeks to reflect the transformative role, without claiming an exhaustive treatment of all the relevant jurisprudence.

The article focuses on the positive obligations of Albanian state and national implementation mechanisms assessing the extent to which the compliance with ECtHR's judgments has contributed to the legislative amendments. It concludes that effective execution triggers broader judicial reform.

Keywords: European Court of Human Rights; European Court of Human Rights; jurisprudence; individual measures; legal reforms.

1. INTRODUCTION

Individual measures are specific legal remedies defined in the operative part of European Court of Human Right's (ECtHR) judgment. Pursuant to Article 46 of the European Convention of Human Rights (ECHR), their purpose is to require the respondent States to take measures to improve the legal position of applicants, by placing them, as far as possible, in the position they would have been in had the violation not occurred. Contracting States, in accordance with the principle of subsidiarity, enjoy autonomy to choose the measures to implement the decisions of the ECHR, while retaining the primary responsibility of the Contracting States to guarantee respect for the rights and freedoms protected by the Convention.(Papamichalopoulos and Others v. Greece (Article 50), § 34) This obligation is also linked to the implementation of Article 1 of the ECHR, which imposes on States the positive obligation to ensure respect for the fundamental rights and freedoms set out in the Convention. Despite the fact that the decisions of the ECtHR are mainly declaratory, in certain cases the Court may instruct states on the individual/general measures that must be taken to eliminate the violations found. (Suso Musa v. Malta, § 120)

This is due to the nature of the violation is such that the determination of the individual measure becomes necessary for the execution of the decision. Hence, they represent a shift from the traditional declaratory approach of the Court's judgments, by directly orienting the execution process and by limiting the discretion of the states in the choice of reparative measures. (Janhn, 2024) As the author Jahn notes, the ordering of individual measures constitutes a mechanism through which the Court clearly address the execution of the decision at the national level, limiting the margin of discretion that the Convention recognizes for the domestic authorities. (Janhn, 2024, p.2)

Over time, the Court's case-law has gradually penetrated national legal orders, while States parties to the Convention have generally shown themselves willing to accept its reparative powers. (Stone Sweet, 2012, p.53) This development has helped limit arbitrariness and inefficiency in domestic political and judicial processes, while simultaneously strengthening the position of the individual vis-à-vis the state. (Hefler, 2008)

Individual measures often highlight the existence of structural problems within the State Parties. Beyond providing redress to the applicant, they may indicate the necessity for broader systemic reforms. This article therefore analyses selected ECtHR judgments against Albania that have surfaced such deficiencies, showing that the state responded not only through the payment of just satisfaction but also by adopting general measures. Illustrative cases concerning various Convention violations are examined to demonstrate the corresponding the legal changes in Albanian domestic law.

2. RESEARCH METHODS

The article adopts a qualitative, doctrinal legal methodology, based on the analyses of legal norms and judicial reasoning. It examines the legal framework governing the execution of ECtHR judgments,

referencing to article 46 of ECHR, and analysis selected judgments of the court concerning Albania and other states. It draws on the ECtHR's HUDOC database, to select the cases based on their significance in illustrating the application of the individual measures and their impact on Albanian legal reforms. In this context, the article relies on relevant academic literature and official documents as well.

3. THE STATUS OF ECHR AND ECTHR JURISPRUDENCE IN ALBANIAN LEGAL ORDER

According to Article 116 of the Constitution of Albania, the Convention as a ratified international agreement holds a supra-legal position in the hierarchy of normative acts, meaning that it is positioned below the Constitution but above ordinary laws. (Parliamentary Assembly, 1998) This hierarchy ensures that if a national law conflicts with the provisions of the Convention, it is considered unconstitutional, as well as anti-conventional. Furthermore, Article 122(2) further asserts the primacy over domestic laws that are incompatible with it. This implies that Albania has a duty to respect its international commitments, giving the European Convention on Human Rights a fundamental importance in the development of the legal system and the guarantee of human rights in the country. Furthermore, Article 5 of the Constitution of Albania expressly provides that the Republic of Albania shall implement the international law that is binding on it. Regarding restrictions on rights and freedoms, Article 17 states that any restrictions must be imposed by law, based on the public interest or the protection of the rights of others. It is important to emphasize that these restrictions must be proportionate to the situation and may not violate the essence of the rights provided for in the Constitution, nor may they exceed the limitations set out in the European Convention on Human Rights.

The status of ECHR and the binding force of the ECtHR jurisprudence has also been consistently affirmed in the case law by the Albanian Constitutional Court and Supreme Court jurisprudence.

In decision no. 22 dated 9 March 2010, the Constitutional Court held that: "...The judgments of the ECHR are are binding on the member states of the Council of Europe, that are parties to the Convention, in accordance with the the commitments arising from Article 46/1 thereof"

Subsequently, in decision no. 20, dated 01 June 2011, the Constitutional Court reaffirmed that the ECtHR has exclusive jurisdiction to interpret the Convention and that its judgments are directly applicable in the domestic legal order, pursuant to Articles 122 and 17/2 of the Constitution, 19 and 46 of the Convention. The court reiterated that in the absence of legislative harmonization with the ECHR, judges at all levels are obliged to directly implement the decisions of the ECHR.

A similar position was adopted by the Criminal Chamber of the Supreme Court, in Decision No. 74 dated 7.3.2012, the Criminal Chamber of the Supreme Court, among other things, assessed that the Supreme Court takes into account the hierarchy of legal norms and judicial decisions, thus giving the decisions of the European Court of Human Rights an important upper place, considering them in this regard, the peak of the pyramid"

This approach was further confirmed in decision no.00-2021-1317, dated 22.7.2021 of Supreme Court of Albania. Accordingly, due to the constitutional status of the ECHR, ordinary courts cannot avoid applying national laws when they consider that they are in conflict with the Convention. (Supreme Court of Albania, 2021, §47)

The Chamber reiterated that the refusal of the courts to directly apply the ECHR and the practice of the ECtHR on the grounds of the absence or contradiction of domestic law and pending legislative or constitutional interventions, is contrary to Article 46 of the ECHR and the obligation to take prompt and effective measures to restore the previous situation. (Supreme Court of Albania, 2021, §148) Thus, the direct implementation of ECHR decisions is essential even in conditions of legislative omission or inconsistencies with domestic law. (Supreme Court of Albania, 2021, §149)

4. INDIVIDUAL MEASURES AND THE ABILITY TO TRIGGER LEGAL REFORMS

Individual measures play an important role in the process of implementing ECtHR judgments, in compliance with Article 46 of the ECHR, not only by addressing specific violations, but also by signaling structural problems that may arise in the legislation or judicial practice of a given State. According to Article 46, in the event of the identification of one or more violations of the provisions of the ECHR, the Court imposes on the State a legal obligation to put an end to the violation and to place the applicant in the position he would have been in if the violation had not been committed (Papamichalopoulos and Others v. Greece (Article 50), 1995, § 34). However, the Contracting State concerned is not only under an obligation to pay the applicant just satisfaction under Article 41 of the ECHR, as an individual measure of a pecuniary nature, but also to take individual non-pecuniary and, if appropriate, general measures in its domestic legal order to put an end to the violation found by the Court and to redress its effects (Ilgar Mammadov v. Azerbaijan [GC], 2019, § 147).

The State party to the case is, in principle, free to choose the means by which it will implement a judgment in which the Court has found a violation. This discretion as to the manner of execution of a judgment reflects the freedom of choice attached to the primary obligation of the Contracting States under the Convention to secure the rights and freedoms guaranteed (Papamichalopoulos and Others v. Greece (Article 50), 1995, § 34). This discretion also serves to assess the ability of national legal systems to translate the Court's decisions into tangible results, as will be evident in the jurisprudence against Albania.

Referring to the jurisprudence against Albania, in addition to determining just compensation under Article 41 of the Convention, i.e. individual measures of a material nature, the Court has also recommended

individual measures of a non-material nature, within the meaning of Article 46, such as: In the case of Ramadhi and Others v. Albania, the Court recommended the return of land as a compulsory measure. (Ramadhi and Others v. Albania, 2007, § 102)

In the case of Gjonbocari v. Albania, structural problems were found in the non-enforcement of final decisions of domestic courts and administrative decisions on the restitution or compensation of property nationalized during the communist regime. This led to a violation of Article 6§1 and Article 1 of Protocol No. 1, as well as the lack of an effective remedy (violation of Article 13 in conjunction with Article 6§1). The Court emphasized that the government must ensure, by appropriate means and promptly, the enforcement of the final decision of the domestic courts. In this context, as an individual non-pecuniary measure, the authorities were requested to provide information on the implementation of the procedures for the enforcement of a Supreme Court's decision. (Gjonbocari and Others v. Albania, 2007)

In the case of Jella and Others v. Albania, (Jella and Others v. Albania, 2024) the Court considered the most appropriate form of reparation to be the demarcation of the land and the registration of the title to the land of the applicants. This was considered a measure which placed the applicants in the situation in which they would have been if the violation had not occurred. If the Government were unable to secure such registration, either in whole or in part, the applicants should receive adequate compensation. (Jella and Others v.Albania,2024, §32)

In the following cases, the ECHR determined just satisfaction in line with Article 41 of the ECHR or individual measures of a non-pecuniary nature based on Article 46. As will be evident, regardless of these measures, the Albanian State showed its willingness and initiative to take general measures with the aim of ending the repetition of the violation of rights but also of solving structural problems.

In Biba v. Albania, the matter concerned a student who suffered a 90% loss of vision after being struck in the eye by a projectile that was fired from a rubber catapult by another student during school hours. (Biba v. Albania, 2024)

The Court reaffirmed its dynamic understanding of "private and family life," interpreting the concept to include both physical and psychological integrity. It held that the injury suffered had a serious and lasting impact on the child's well-being, thus bringing the incident within the protective scope of Article 8. Notably, the Court treated school safety as an emerging area that necessitates proactive State intervention. Through an evolutive interpretation, it integrated institutional accountability in education into the framework of Convention rights (Biba v. Albania, 2024, §§41–43).

Emphasizing children's vulnerability and the institutional responsibilities of schools, the Court held that Article 8 requires not only non-interference but also the active enforcement of safety standards. Both public and private educational institutions are obliged to maintain discipline and prevent violence throughout the school day. Drawing on its earlier jurisprudence, the Court emphasized that States cannot delegate responsibility to private actors. Effective supervision and legal safeguards are essential to fulfilling Article 8 obligations, particularly in cases involving peer-on-peer violence and the presence of dangerous objects (Biba v. Albania, 2024, §§ 59–60, 66–68, 71–73, 77).

Upon reviewing the Albanian legal and institutional framework, especially Section 66 of Law No. 7952 and the supervisory role of the Ministry of Education, the Court acknowledged the existence of some preventive mechanisms. However, it found that enforcement was inadequate. The failure to ensure preventive supervision and effective legal remedies constituted a breach of Albania's positive obligations under Article 8. The Court concluded that States must implement practical and effective measures, not merely theoretical frameworks, to protect children from foreseeable risks within educational settings.

In response to the Court's judgment, the Albanian Government submitted a Revised Action Plan on 7 February 2025 to the Committee of Ministers (1521st meeting, March 2025), (Albania, 2025) outlining systemic reforms to implement the ruling. Among the key measures was the national rollout of a "School Safety Package" in 2024, which deployed 240 security officers to schools across the country to address bullying, violence, and cyberbullying. Complementary initiatives included the "Smart City" project, aimed at improving public and school safety through upgraded surveillance infrastructure. Capacity-building efforts were also enhanced through OSCE-led training sessions on conflict de-escalation. Furthermore, Albania advanced its cooperation with the Council of Europe via the "Strengthening Democratic Citizenship Education" project, which promotes human rights and democratic values in school curricula.

The case of Xheraj v. Albania represents a significant milestone in the domestic enforcement of ECtHR judgments within Albania. The applicant contended that the Supreme Court undermined legal certainty by permitting a prosecutor to challenge a final acquittal beyond the established legal deadline. The ECtHR determined that there was a breach of Article 6(1), highlighting the importance of the finality of judicial decisions and safeguarding individual legal expectations (Xheraj v. Albania, 2008). Importantly, the Court invoked Article 41 to assert that reopening proceedings constituted an effective remedy, even in the absence of a specific legal provision in Albanian law permitting such actions. This ruling implicitly utilized evolutive interpretation: although the Convention does not prescribe particular domestic procedures for the execution of ECtHR judgments, the Court's rationale encouraged the amendment of national law to guarantee the practical and effective implementation of Strasbourg decisions. The consequences of this ruling are noteworthy. The Constitutional Court mandated the Supreme Court to reopen the case (Constitutional Court of Albania, 2010), resulting in the annulment of the applicant's conviction and the expungement of his criminal record (Supreme Court of Albania, 2012). Following this, Albania revised Article 450(d) of its Criminal Procedure Code (Law No. 7905/1995) (Assembly of

Albanian Republic, 1995) to explicitly permit the reopening of proceedings in instances of ECtHR violations. This legislative change exemplifies how evolutive interpretation can drive systemic legal reforms to ensure that domestic law aligns with the evolving obligations of human rights.

In Dauti v. Albania, the ECtHR held that the lack of judicial review over decisions by the Appeals Commission violated the applicant's right to a fair trial under Article 6 (Dauti v. Albania, 2009). Albanian courts had previously deemed these decisions final and unchallengeable. The Court's ruling required not merely the correction of an individual violation but the evolution of national legislation to ensure access to justice. This judgment prompted the Albanian legislature to amend Law No. 7703 ("On Social Insurance") through Law No. 10 447 of 14 July 2011 (Assembly of Albanian Republic, 2011), introducing judicial oversight over such decisions. However, concerns persisted about the practical implementation of the reform. In 2021, the Supreme Court raised questions regarding its authority to directly apply international law and the legal significance of the enforcement decisions made by the Committee of Ministers. In Decision No. 55/2021, the Constitutional Court opted not to offer a binding interpretation, choosing instead to defer the matter to the Supreme Court. (Constitutional Court of Albania, 2021). The Supreme Court later determined that the revised law continued to fall short of meeting the criteria outlined in Article 6. It declared the conflicting provisions inoperable and reaffirmed the duty of national courts to apply the ECHR directly, even in the face of contradictory domestic law (Supreme Court of Albania, 2021). The case reflects the Court's evolutive approach to access to justice, expanding the reach of procedural protections. It further affirms the primacy of ECtHR jurisprudence in directing national legal reform, thereby reinforcing the living character of the Convention.

In Luli and Others v. Albania, the European Court of Human Rights found a violation of Article 6 § 1 on account of the excessive length of judicial proceedings, stressing that undue delays undermine the fairness of a trial irrespective of its complexity. (Luli and Others v. Albania, 2014, §92). The Court observed that repeated referrals for re-examination by administrative bodies exposed systemic deficiencies within Albania's legal framework. Moreover, consistent with its earlier case law against Albania, the Court held that no effective domestic remedy existed for complaints concerning the length of proceedings, underscoring a structural flaw in the national legal system. According to Article 6, States are required to organize their judicial systems so that competent authorities can resolve cases within a reasonable timeframe. This involves taking procedural steps like consolidating cases, halting unnecessary actions, or dismissing repetitive claims to comply with the Convention's time constraints. In its analysis under Article 46, the Court went beyond individual redress and called for structural reforms, urging Albania to introduce an effective remedy for excessive judicial delays (Luli and Others v. Albania, 2014, §§ 116–118). The judgment exemplifies the Court's reliance on evolutive interpretation, treating the Convention as a "living instrument" that necessitates the adaption of domestic law to contemporary standards of justice. Its expansive reading of "reasonable time" under article 6 reflects a dynamic understanding of procedural fairness, addressing systematic dysfunction instead of isolated delays.

Following the judgment, Albania enacted Law No. 38/2017, amending Title III of the Civil Procedure Code (CPC) by adding Chapter X on "Examination of Requests Concerning Violations of the Reasonable Timeframe, Acceleration of Procedures, and Compensation for Damages" (covering Articles 399/1 to 399/12) (Assembly of Albanian Republic, 1991). These provisions sought to mitigate procedural delays by establishing clear timelines for various stages of the judicial process, thereby enhancing efficiency and alleviating court backlogs. This legislative response demonstrates the practical impact of evolutive interpretation, whereby the ECtHR's ruling catalyzed the alignment of Albania's domestic legal system with contemporary human rights obligations and strengthened the effectiveness of the Convention in practice.

The case of Bajrami v. Albania concerned the failure of the Albanian authorities to fulfil their positive obligation to guarantee the applicant's right to family life, specifically reunification with his daughter, in breach of Article 8 of the Convention.

The Court found that, following the separation, the applicant was almost completely deprived of contact with his child and that, despite his requests and warnings of abduction of the child by his ex-wife, the authorities failed to prevent the daughter from leaving the country without his consent, nor to subsequently enforce the court decision granting him custody.

In this situation, the Court highlighted the fact that the legal system did not provide for any effective legal means to prevent or punish child abduction, nor an alternative to enable family reunification, (Bajrami v. Albania, 2006 § 67) and concluded that the authorities' efforts were neither sufficient nor effective to fulfil this positive obligation, leading to a violation of Article 8 of the Convention. (Bajrami v. Albania, 2006 §§ 68-69)

In response to the findings and problems in the legal framework regarding the protection of children, and in particular protection from international abductions, the Albanian state ratified the Hague Convention "On the Civil Aspects of International Child Abduction".(1980) The purposes of this Convention are: a. to secure the prompt return of children wrongfully removed or retained in a Contracting State; and b. to ensure that rights of custody and contact under the law of a Contracting State are effectively respected in other Contracting States.(Article 1)

As part of the measures taken to implement the ECHR decision, Law No. 18/2017 'On the Rights and Protection of the Child' was adopted. (2017) This law transposed the UNCRC convention into the domestic legal system and defined the institutional mechanisms responsible for protecting children's rights. (Article 34)

Another reform regarding the execution of decisions was the adoption of Law No. 26/2019 "On the private bailiff service", adopted on 8.5.2019, which repealed Law No. 10 031, dated 11.12.2008, "On the private bailiff service", as amended. (Assembly of Albanian Republic, 2019) According to Article 53, point 3, in cases of execution of executive titles that have as their object the visitation and custody of the child, the private judicial enforcement officer has the obligation to notify the child protection unit at the structure responsible for social services in the municipality, as well as to request the assistance of a psychologist.

As an additional preventive measure, Albania has introduced a biometric passport system for children, increasing the security of travel documents. (Albania, 2018, §§19-20)

After examining the action report provided by the government indicating the measures taken to implement the Bajrami v. Albania judgment, the Committee of Ministers decided to close its examination. (Committee of Ministers, 2018)

5. CONCLUSION

The article highlighted that individual measures imposed by the European Court of Human Rights have played an important role in advancing legal reforms within the Albanian legal system. In addition to addressing individual cases, these measures have often highlighted structural deficiencies in domestic legislation and judicial practices, prompting the state to respond with normative and institutional changes. In this context, they constitute a fundamental aspect of the process of executing decisions by making rights practical and not illusory. They are also a determining factor in transforming Strasbourg decisions into tangible results within the national legal framework.

References

1. Albania. (2018, March 27). Action report (27/03/2018) – Communication from Albania concerning the case of Bajrami v. Albania (Application No. 35853/04), 1318th meeting (June 2018) (DH). HUDOC-EXEC. Retrieved January 30, 2026, from https://hudoc.exec.coe.int/?i=DH-DD(2018)369E

2. Albania. (2025, February 7). Revised Action Plan (07/02/2025) - Communication from Albania concerning the case of Biba v. Albania (Application No. 24228/18),1521st meeting (March 2025) (DH). HUDOC-EXEC. Retrieved January 30, 2026, from https://hudoc.exec.coe.int/eng?i=DH-DD(2025)147revE

3. Assembly of Albanian Republic. (1991, April 29). Law No.7491 "Code of the Civil Procedure of the Republic of Albania." EURALIUS. Retrieved January 30, 2026, fromhttps://euralius.eu/index.php/en/library/albanian-legislation?task=download.send&id=172&catid=11&m=0

4. Assembly of Albanian Republic. (1995, March 21). Law No.7905 "CRIMINAL PROCEDURE CODE OF THE REPUBLIC OF ALBANIA". EURALIUS. Retrieved January 30, 2026, from https://euralius.eu/index.php/en/library/albanian-legislation?task=download.send&id=172&catid=11&m=0

5. Assembly of Albanian Republic. (2011, July 14). Law No.10447 "On some additional provisions on the law 7703/1993 "On social security".

6. Assembly of Albanian Republic. (2017, February 23). Law No. 18/2017 on the Rights and Protection of the Child.

7. Assembly of Albanian Republic. (2019, May 8). Law No. 26/2019 "On the Private Bailiff Service." Qendra e Botimeve Zyrtare. Retrieved January 30, 2026, from https://qbz.gov.al/eli/ligj/2019/05/08/26/33ad5732-eb8b-443f-910f-ef8bdc0eb71d

8. Bajrami v. Albania. (2006, December 12). European Court of Human Rights. HUDOC – European Court of Human Rights, Application no. 35853/04. Retrieved January 30, 2026, from https://hudoc.echr.coe.int/?i=001-78425

9. Biba v. Albania. (2024, May 7). European Court of Human Right,Application no. 24228/18. HUDOC - European Court of Human Rights. Retrieved January 30, 2026, from https://hudoc.echr.coe.int/eng?i=001-233411

10. Committee of Ministers of the Council of Europe. (2018, May 2). Resolution CM/ResDH(2018)173 – Execution of the judgments of the European Court of Human Rights: Bajrami v. Albania, 1315th meeting of the Ministers' Deputies. HUDOC-EXEC. Retrieved January 30, 2026, from https://hudoc.exec.coe.int/?i=001-183106

11. Constitutional Court of Albania. (2010, March 9). Decision no. 22. Gjykata Kushtetuese. Retrieved January 30, 2026, from http://gjk.gov.al

12. Constitutional Court of Albania. (2010, May 5). Decision no. 22. Gjykata Kushtetuese. Retrieved January 30, 2026, from http://gjk.gov.al

13. Constitutional Court of Albania. (2011, June 1). Decision no. 20. Gjykata Kushtetuese. Retrieved January 30, 2026, from http://gjk.gov.al

14. Constitutional Court of Albania. (2021, March 31). Decision no. 55. Gjykata Kushtetuese. Retrieved January 30, 2026, from https://www.gjk.gov.al/

15. Council of Europe. (1950, November 4). European Convention on Human Rights. ECHR. Retrieved January 30, 2026, from https://www.echr.coe.int/documents/d/echr/Convention_ENG

16. Dauti v. Albania. (2009, February 3). European Court of Human Rights,. HUDOC - European Court of Human Rights,Application no. 19206/05. Retrieved January 30, 2026, from https://hudoc.echr.coe.int/eng?i=001-91103

17. Gjonbocari and Others v. Albania. (2007, October 23). European Court of Human Rights. HUDOC – European Court of Human Rights, Application no. 10508/02. Retrieved January 30, 2026, from https://hudoc.echr.coe.int/?i=001-82863

18. Hague Convention on the Civil Aspects of International Child Abduction. (1980, October 25). Ratified by Albania, Law no. 9446, 24 November 2005.

19. Helfer, L. R. (2008). Redesigning the European Court of Human Rights: Embeddedness as a deep structural principle of the European human rights

regime. *European Journal of International Law, 19*(1), 125–159. https://doi.org/10.1093/ejil/chn004

20. Ilgar Mammadov v. Azerbaijan. (2019, May 29). European Court of Human Rights. HUDOC – European Court of Human Rights, Application no. 15172/13. Retrieved January 30, 2026, from https://hudoc.echr.coe.int/?i=001-193543

21. Jahn, J. (2014). Ruling (in)directly through individual measures? Effect and legitimacy of the ECtHR's new remedial power. *ZaöRV, 74*, 1–39. Retrieved January 30, 2026, from https://www.zaoerv.de/74_2014/74_2014_1_a_1_40.pdf

22. Jella and Others v. Albania. (2024, March 5). European Court of Human Rights. HUDOC – European Court of Human Rights, Application no. 7564/07. Retrieved January 30, 2026, from https://hudoc.echr.coe.int/?i=001-231333

23. Luli and Others v. Albania. (2014, April 1). European Court of Human Rights,Applications nos. 64480/09, 64482/09, 12874/10, 56935/10, 3129/12 and 31355/09. HUDOC - European Court of Human Rights. Retrieved January 30, 2026, from https://hudoc.echr.coe.int/eng?i=001-142305

24. Papamichalopoulos and Others v. Greece (Article 50). (1995, October 31). European Court of Human Rights. HUDOC – European Court of Human Rights, Application no. 14556/89. Retrieved January 30, 2026, from https://hudoc.echr.coe.int/?i=001-57961

25. Parlamentary Assembly. (1998, October 21). Constitution of the Republic of Albania, Adopted by Law no. 8417, dated 21.10.1998. Retrieved January 30, 2026, from https://euralius.eu/index.php/en/library/albanian-legislation?task=download.send&id=178&catid=9&m=0

26. Ramadhi and Others v. Albania. (2007, November 13). European Court of Human Rights. HUDOC – European Court of Human Rights, Application no. 38222/02. Retrieved January 30, 2026, from https://hudoc.echr.coe.int/?i=001-83249

27. Stone Sweet, A. (2012). A cosmopolitan legal order: Constitutional pluralism and rights adjudication in Europe. *Journal of Global Constitutionalism, 1*(1), 53–90. Retrieved January 30, 2026, from https://ssrn.com/abstract=1913657

28. Supreme Court of Albania. (2012, March 7). Decision no. 01226/2011.

29. Supreme Court of Albania. (2021, July 22). Decision no. 00-2021-1317.

30. Suso Musa v. Malta. (2013, July 23). European Court of Human Rights. HUDOC – European Court of Human Rights, Application no. 42337/12. Retrieved January 30, 2026, from https://hudoc.echr.coe.int/?i=001-122893

31. Xheraj v. Albania. (2008, July 29). European Court of Human Rights,Application no. 37959/02. HUDOC - European Court of Human Rights. Retrieved January 30, 2026, from https://hudoc.echr.coe.int/eng?i=001-87964

ODONTOGENIC SUBMANDIBULAR PHLEGMON: A SYNTHETIC REVIEW

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Abstract

Odontogenic submandibular phlegmon is a severe, rapidly progressive infection of the deep cervical fascial spaces, originating from untreated or inadequately treated dental infections. It is characterized by diffuse inflammatory infiltration without clear abscess formation and carries a high risk of life-threatening complications, including airway obstruction, descending mediastinitis, and sepsis. Early diagnosis and aggressive multidisciplinary management are essential to reduce morbidity and mortality. This review summarizes current evidence regarding epidemiology, pathophysiology, clinical presentation, diagnostic approach, and therapeutic strategies for odontogenic submandibular phlegmon.

Keywords: submandibular space, odontogenic phlegmon

1. INTRODUCTION

Odontogenic infections remain one of the most common causes of deep neck space infections worldwide. When dental infections extend beyond the alveolar bone and penetrate the surrounding fascial planes, they may give rise to diffuse inflammatory processes known as phlegmons. Unlike circumscribed abscesses, phlegmons are non-encapsulated, infiltrative infections that spread rapidly through connective tissue planes.

The submandibular space is particularly vulnerable due to its anatomical relationship with the mandibular molars and the mylohyoid muscle. Odontogenic submandibular phlegmon represents a medical and surgical emergency, requiring prompt recognition and treatment to prevent airway compromise and systemic dissemination.

2. ETIOPATHOGENY

Mandibular molars (especially second and third molars), are the most frequent odontogenic sources of submandibular infections. Several studies report that 40–70% of deep odontogenic infections involving cervical spaces originate from lower molars.

Common predisposing factors include:

- delayed or inadequate dental treatment,
- poor oral hygiene,
- diabetes mellitus,
- immunosuppression,
- alcohol and tobacco use,
- recent dental extractions without appropriate antibiotic coverage.

The condition affects adults more frequently, with a slight male predominance reported in most series.

The submandibular space is anatomically divided into the sublingual and submylohyoid compartments by the mylohyoid muscle. Infections originating from mandibular molars whose apices lie below the mylohyoid line tend to spread directly into the submandibular space.

Once the cortical bone is breached, bacteria disseminate through loose areolar tissue, producing diffuse edema, vascular congestion, and tissue necrosis. The absence of anatomical barriers facilitates extension to adjacent spaces, including:

- sublingual space,
- parapharyngeal space,
- masticator space,
- retropharyngeal space.

Polymicrobial flora predominates, with anaerobic bacteria and viridans group streptococci being most frequently isolated.

3. CLINICAL CHART

Patients typically present with:

- painful, firm swelling in the submandibular region,
- trismus,
- dysphagia and odynophagia,
- fever and systemic inflammatory response,
- elevation of the floor of the mouth and tongue displacement.

In advanced cases, airway compromise may occur, particularly when bilateral involvement leads to Ludwig's angina. The overlying skin may appear tense, erythematous, and warm, while fluctuation is often absent in early stages.

4. DIAGNOSTIC

Imaging

Contrast-enhanced computed tomography (CT) is the imaging modality of choice. It allows precise assessment of:

- extent of fascial space involvement,
- differentiation between phlegmon and abscess,
- airway compression,

- mediastinal extension.

Magnetic resonance imaging (MRI) may offer superior soft-tissue contrast but is less readily available in emergency settings.

Laboratory

Laboratory tests typically reveal leukocytosis, elevated C-reactive protein, and other markers of systemic inflammation. Blood cultures are recommended in severe cases or when sepsis is suspected.

5. TREATMENT

Management must be prompt, aggressive and multidisciplinary.

Airway Management

Airway protection is the first priority. Endotracheal intubation or tracheostomy may be required in patients with progressive swelling or respiratory distress.

Antibiotic therapy

Empirical broad-spectrum intravenous antibiotics should be initiated immediately, covering aerobic and anaerobic oral flora. Common regimens include: amoxicillin-clavulanate or piperacillin-tazobactam, combined with metronidazole when necessary. Antibiotic therapy should be adjusted based on culture and sensitivity results.

Surgical Management

Surgical intervention is mandatory in most cases and includes:

- wide cervical incision and drainage,
- removal of necrotic tissue,
- extraction of the causative tooth,
- placement of drains to prevent re-accumulation. (fig.1)

Conservative antibiotic therapy alone is generally insufficient in advanced phlegmonous infections.

Fig. 1

6. COMPLICATIONS

Potential complications include:

- Ludwig's angina,
- descending necrotizing mediastinitis,
- septic shock,
- internal jugular vein thrombosis,
- multi-organ failure.

Mortality rates increase significantly in cases with delayed diagnosis or inadequate airway

7. CONCLUSIONS

Odontogenic submandibular phlegmon is a life-threatening condition requiring early diagnosis and prompt, aggressive management. Contrast-enhanced CT, broad-spectrum antibiotics, airway control, and surgical drainage form the cornerstone of therapy.

The literature consistently emphasizes the aggressive nature of odontogenic submandibular phlegmon and the importance of early surgical intervention. Outcomes are significantly improved when treatment is initiated before abscess formation or airway compromise occurs.

Interdisciplinary collaboration between oral and maxillofacial surgeons, otolaryngologists, anesthesiologists, and intensivists is essential. Increased awareness among dental and medical professionals is critical for reducing associated morbidity and mortality.

References

1. Britt J.C., et al. Odontogenic infections and deep neck space involvement. Int J Oral Maxillofac Surg.

2. Bali R.K., et al. A review of complications of odontogenic infections

National Journal of Maxillofacial Surgery, 2015, 6(2):p 136-143

3. de la Cámara Gómez M, et al. Submandibular phlegmon secondary to odontogenic infection. Emergencias, 2006

4. Flynn TR. Principles of management of odontogenic infections. Oral Maxillofac Surg Clin North Am., 2015

5. Boscolo-Rizzo P, et al. Deep neck infections: a study of 365 cases. Eur Arch Otorhinolaryngol., 2012

ATYPICAL LOCALIZATIONS OF ECHINOCOCCOSIS – A SYNTHETIC REVIEW

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Abstract
Echinococcosis is a parasitic zoonosis caused by the larval forms of the genus Echinococcus, particularly E. granulosus and E. multilocularis, representing a major public health concern in endemic regions [3,5]. The liver (≈70%) and lungs (≈20%) are the classical sites of infection [4,7]. In 10–15% of cases, atypical localizations occur, presenting with nonspecific clinical manifestations and significant diagnostic challenges [6,14]. Accurate diagnosis and appropriate management are essential to prevent severe complications [1,10].

Keywords: echinococcosis, atypical localizations

INTRODUCTION

Cystic echinococcosis is a helminthic infection caused by the larval stage of Echinococcus granulosus, with humans acting as accidental intermediate hosts [4]. Transmission occurs through ingestion of eggs shed by the definitive host, most commonly the dog [5].

After penetrating the intestinal mucosa, hexacanth embryos enter the portal circulation and are predominantly retained in the liver. Some larvae bypass the hepatic and pulmonary filters and reach the systemic circulation, resulting in extrahepatic and extrapulmonary localizations [6,14].

The currently recommended imaging classification is that proposed by the WHO-IWGE [1,25].

Atypical localizations occur through:

- bypassing the hepato-pulmonary filter [6]
- systemic hematogenous dissemination [14]
- lymphatic spread
- spontaneous or traumatic rupture of a primary cyst [11]
- intraoperative iatrogenic dissemination [19]

ATYPICAL LOCALIZATIONS

Cerebral localization - occurs in 1–2% of cases, more frequently in children and adolescents [8]. Clinically, it presents with signs of intracranial hypertension, seizures, and focal neurological deficits [8,18]. CT and MRI reveal a well-defined cystic lesion with cerebrospinal fluid–like content [13,18]. Treatment is surgical (Dowling-Orlando technique), combined with albendazole therapy [1,8].

Cardiac localization - represents 0.5–2% of cases [9,17]. The left ventricle is most commonly affected [17]. Clinical manifestations include chest pain, arrhythmias, dyspnea, or syncope [9].

Severe complications may occur, such as systemic embolism, intrapericardial rupture, and cardiac tamponade [17]. Diagnosis is based on echocardiography and cardiac MRI [9].

Treatment consists of surgical excision under extracorporeal circulation, associated with antihelminthic therapy [1,17].

Osseous localization - occurs in 0.5–4% of cases [12]. The vertebrae, pelvis, and long bones are most frequently involved [12]. The lesion has an infiltrative pattern without formation of a well-defined pericyst, mimicking malignant pathology [6]. Clinically, it presents with chronic pain and pathological fractures [12]. Prognosis is guarded due to frequent recurrences [12].

Splenic localization - accounts for 2–6% of cases [20]. Clinically presents with splenomegaly and left upper quadrant pain [20]. Imaging findings are similar to those of hepatic localization [13]. Standard treatment is splenectomy or selective spleen-preserving surgery [20].

Renal localization - incidence ranges between 2–4% [21]. The pathognomonic sign is hydatiduria, which is rarely observed [21]. Differential diagnosis includes cystic renal tumors and complicated urinary infections [21]. Treatment is surgical, preferably organ-preserving when feasible [21].

Muscular and subcutaneous localization - represents 1–3% of cases [14,24]. It presents as a painless, slowly progressive mass [24]. Differential diagnosis includes sarcoma and cold abscess [6]. Treatment consists of complete surgical excision [1].

Peritoneal localization - usually secondary to rupture of a hepatic cyst [11]. May cause ascites and multiple intra-abdominal dissemination [15]. The major complication is anaphylactic reaction [11].

Pancreatic localization – is rare (0.2–2%) [22]. The pancreatic head is most commonly involved, leading to obstructive jaundice [22]. May present with epigastric pain or pancreatitis [22]. Differential

diagnosis includes pancreatic pseudocyst and cystic neoplasms [22]. Treatment is surgical, tailored to localization, combined with albendazole therapy [1,22].

Thyroid localization – is extremely rare (<1%) [23]. Presents as a painless thyroid nodule,usually with normal thyroid function [23]. Differential diagnosis includes simple thyroid cyst and cystic carcinoma [23]. Fine-needle aspiration is controversial due to the risk of dissemination [23]. Treatment consists of lobectomy or partial thyroidectomy [1,23].

Diagnosis

Imaging (ultrasound, CT, MRI) is essential for identifying lesions and classifying them according to WHO-IWGE criteria [1,25].

Serology (ELISA, Western blot) shows variable sensitivity, lower in isolated localizations [3,5].

Treatment

Combined surgical and medical treatment (albendazole 10–15 mg/kg/day) is recommended in most cases [1,10].

The PAIR technique is reserved for selected situations [1].

CONCLUSION

Atypical localizations of echinococcosis represent a major diagnostic challenge, as they may mimic neoplastic or inflammatory diseases [6,14]. In endemic areas, echinococcosis should be included in the differential diagnosis of any atypical cystic lesion. Multidisciplinary management and adherence to international guidelines are essential to reduce morbidity and mortality [1,3].

References

1. Brunetti E, Kern P, Vuitton DA; Writing Panel for the WHO-IWGE. Expert consensus for the diagnosis and treatment of cystic and alveolar echinococcosis in humans. Acta Trop. 2010;114(1):1-16.

2. Vuitton DA, McManus DP, Rogan MT, et al. International consensus on terminology to be used in the field of echinococcoses. Parasite. 2020;27:41.

3. Wen H, Vuitton L, Tuxun T, et al. Echinococcosis: advances in the 21st century. Clin Microbiol Rev. 2019;32(2):e00075-18.

4. McManus DP, Zhang W, Li J, Bartley PB. Echinococcosis. Lancet. 2003;362(9392):1295-304.

5. Moro P, Schantz PM. Echinococcosis: a review. Int J Infect Dis. 2009;13(2):125-33.

6. Polat P, Kantarci M, Alper F, et al. Hydatid disease from head to toe. Radiographics. 2003;23(2):475-94.

7. Pakala T, Molina M, Wu GY. Hepatic and extrahepatic echinococcosis: a review. World J Gastroenterol. 2016;22(20):5867-78.

8. Turgut M. Hydatid disease of the brain: a review of 117 cases. Neurosurg Rev. 2001;24(4):200-8.

9. Neumayr A, Ahmed M, Akhan O, et al. Echinococcosis of the heart: clinical and imaging features. Int J Cardiol. 2013;167(6):1127-34.

10.Tamarozzi F, Akhan O, Cretu CM, et al. Epidemiology and clinical management of cystic echinococcosis in Europe. Lancet Infect Dis. 2018;18(8):e275-e287.

11. Dziri C, Haouet K, Fingerhut A. Treatment of hydatid cyst of the liver: where is the evidence? World J Surg. 2004;28(8):731-6.

12. Sapkas G, Stathakopoulos DP, Babis GC, Tsarouchas J. Hydatid disease of bones and joints. Acta Orthop Belg. 1998;64(3):317-21.

13. Pedrosa I, Saíz A, Arrazola J, Ferreirós J, Pedrosa CS. Hydatid disease: radiologic and pathologic features and complications. Radiographics. 2000;20(3):795-817.

14. Kiresi DA, Karabacakoglu A, Odev K, Karaköse S. Uncommon locations of hydatid cysts. Acta Radiol. 2003;44(6):622-36.

15. Ilica AT, Kocaoglu M, Zeybek N, et al. Extrahepatic abdominal hydatid disease: imaging findings. AJR Am J Roentgenol. 2007;189(2):337-43.

16. Kammerer WS, Schantz PM. Echinococcal disease. Infect Dis Clin North Am. 1993;7(3):605-618.

17. Tuxun T, Zhang JH, Zhao JM, et al. World review of cardiac hydatid disease. World J Cardiol. 2015;7(4):186-94.

18. Erdem CZ, Erdem LO. Radiological characteristics of cerebral hydatid disease. Clin Imaging. 2001;25(4):256-61.

19. Kapan M, Kapan S, Goksoy E, et al. Postoperative recurrence in hepatic hydatid disease. J Gastrointest Surg. 2006;10(5):734-9.

20. Safioleas M, Misiakos EP, Dosios T, et al. Surgical treatment for splenic hydatidosis. World J Surg. 1997;21(4):374-8.

21. Horchani A, Nouira Y, Chtourou M, et al. Renal hydatid cyst: diagnosis and treatment. World J Surg. 2000;24(1):68-74.

22. Akbulut S. Hydatid cyst of the pancreas: report of cases and review of the literature. World J Gastroenterol. 2014;20(45):16450-60.

23. Kucuk HF, Kaptanoglu L, Kurt N, et al. Hydatid cyst of the thyroid gland: a rare case report. Surg Today. 2008;38(7):632-4.

24. Mushtaque M, Mir MF, Malik AA, et al. Hydatid disease at unusual sites. Int J Surg. 2012;10(9):547-50.

25. WHO Informal Working Group on Echinococcosis (IWGE). International classification of ultrasound images in cystic echinococcosis. Acta Trop. 2003;85(2):253-61.

MEDICAL SCIENCES

OVARIAN CYSTS - CURRENT APPROACHES

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Abstract

Ovarian cysts represent a broad spectrum of adnexal lesions, ranging from benign functional cysts, to complex neoplasms with malignant potential. They are frequently encountered in clinical practice and often detected incidentally through imaging. Accurate diagnosis is essential to guide appropriate management, while avoiding unnecessary surgical intervention. Advances in imaging, including standardized risk stratification systems such as the Ovarian-Adnexal Reporting and Data System (O-RADS), have significantly improved diagnostic accuracy (1,2). Management strategies are increasingly individualized, based on patient age, symptomatology, cyst morphology, and malignancy risk. This review summarizes current evidence on the diagnosis, risk assessment, and treatment of ovarian cysts, emphasizing contemporary guidelines and studies published in the last 10 years.

Keywords: ovarian cysts, laparoscopy, risk stratification

1. Introduction

Ovarian cysts are among the most common gynecological findings, particularly in women of reproductive age. While most are benign and self-limiting, a minority may represent borderline or malignant disease. Differentiating between these entities remains a key clinical challenge. Recent developments in standardized ultrasound reporting systems and validated prediction models have improved diagnostic precision and optimized referral pathways [1–3].

2. Classification of Ovarian Cysts

Ovarian cysts are broadly classified into:

- functional cysts: follicular cysts and corpus luteum cysts, hormonally mediated and typically self-resolving.
- benign pathological cysts: endometriomas, mature cystic teratomas, serous and mucinous cystadenomas.
- borderline and malignant tumors.

Functional cysts usually regress spontaneously, whereas pathological cysts often persist and may require intervention depending on symptoms and imaging characteristics [3].

3. Diagnosis

a. Clinics

Symptoms range from asymptomatic incidental findings, to pelvic pain, bloating, menstrual irregularities, or acute abdomen due to torsion or rupture. Thorough history and physical examination are essential, although limited in sensitivity for malignancy [6].

b. Laboratory

Serum CA-125 is widely used as an adjunctive biomarker, particularly in postmenopausal women. Its specificity is limited, because elevations may occur in benign conditions, such as endometriosis or pelvic inflammatory disease.

Advanced markers (HE4, multivariate index assays) may improve accuracy, but are not universally adopted [5,7].

c. Imaging

Transvaginal Ultrasound (TVUS) is the first-line imaging modality. Key features include cyst size, wall characteristics, septations, papillary projections, and vascularity [3,8].

O-RADS classification provides standardized ultrasound descriptors and stratifies adnexal lesions by malignancy risk. Validation studies show high sensitivity and specificity for guiding clinical decisions [1,2].

Magnetic Resonance Imaging (MRI) is recommended for indeterminate lesions. O-RADS MRI scoring further refines risk assessment using lesion composition, enhancement, and diffusion-weighted imaging [1,6].

d. Risk Prediction

International Ovarian Tumor Analysis (IOTA) simple rules and ADNEX models integrate clinical and sonographic features to estimate malignancy risk. These tools have been validated externally and assist in surgical referral decisions [3-4,7].

4. Management

a. Conservative treatment

Asymptomatic, simple cysts in premenopausal women, are managed expectantly. Most functional cysts resolve within 2–3 cycles. Follow-up imaging is recommended based on size, morphology, and patient age [2,5].

b. Medical therapy

Hormonal contraception reduces recurrence of functional cysts, but does not accelerate resolution of existing cysts [5].

c. Surgery

Indications for surgery include persistent, enlarging, symptomatic, or complex cysts and high-risk lesions. Laparoscopic cystectomy is preferred; laparotomy is reserved for large or suspicious masses [5,6].

d. Special Considerations

Postmenopausal Women: simple cysts <3 cm, with normal CA-125, may be observed. Complex or enlarging cysts require further evaluation [5].

Adolescents and Fertility Preservation - ovarian-sparing surgery is prioritized. Detorsion is recommended even if ovary appears ischemic, as functional recovery is common [7].

5. Complications

Ovarian torsion, rupture, and hemorrhage are major complications. Torsion is a surgical emergency requiring urgent intervention. Rupture management depends on hemodynamic stability [6].

AI-assisted imaging, advanced MRI, and biomarker integration are promising strategies to reduce diagnostic uncertainty and unnecessary surgery [1,6].

7. Conclusion

Ovarian cyst management relies on accurate imaging and validated risk stratification systems. Most cysts are safely managed conservatively, while surgery is reserved for symptomatic or high-risk lesions. Advances in imaging and predictive models continue to enhance individualized patient care [1–3].

AI-assisted imaging, advanced MRI, and biomarker integration are promising strategies to reduce diagnostic uncertainty and unnecessary surgery [1,6].

Table 1.

O-RADS Ultrasound Risk Stratification System

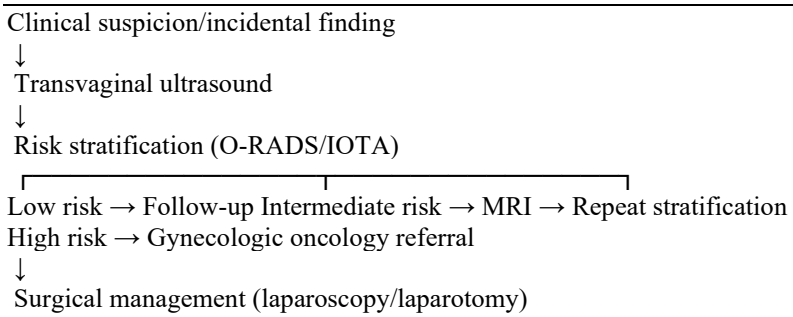
O-RADS Category	Estimated Malignancy Risk	Typical Ultrasound Features	Repeat or alternative imaging
0	incomplete	inadequate imaging	
1	0%	Normal ovary	routine care
2	<1%	simple cyst, unilocular, thin-walled	no follow-up
3	1–10%	multilocular smooth cyst <10 cm	follow-up ultrasound
4	10–50%	solid components, papillary projections	specialist referral
5	>50%	irregular solid mass, ascites, high Doppler flow	oncology referral

Table 2.

Management of ovarian cysts according to risk and patient characteristics

Patient Group	Cyst Type	Recommended Management
Premenopausal	Simple cyst <5 cm	Expectant management
Expectant management	Persistent/complex cyst	Follow-up or surgery
Postmenopausal	Simple cyst <3 cm, normal CA-125	Conservative follow-up
Postmenopausal	Complex/enlarging cyst	Surgical evaluation
Adolescents	Any cyst	Ovarian-sparing approach preferred

Figure 1. *Diagnostic and Management Algorithm for Ovarian Cysts*



References

1. Strachowski LM, Froyman W, Patel MD, et al. O-RADS US v2022: An update from the American College of Radiology Ovarian-Adnexal Reporting and Data System ultrasound working group. Radiology. 2023; 307(2):e230685.

2. Andreotti RF, Timmerman D, Strachowski LM, et al. O-RADS US risk stratification and management system: A consensus guideline from the ACR Ovarian-Adnexal Reporting and Data System Committee. Radiology. 2020; 294(1):168–185.

3. Timmerman D, Valentin L, Bourne TH, et al. Terms, definitions and measurements to describe the sonographic features of adnexal tumors: A consensus opinion from the IOTA group. Ultrasound Obstet Gynecol. 2016;48(1):1–10.

4. Van Calster B, Van Hoorde K, Valentin L, et al. Evaluating the performance of the ADNEX model for the diagnosis of ovarian tumors. BMJ. 2014;349:5920.

5. Royal College of Obstetricians and Gynaecologists. The management of ovarian cysts in postmenopausal women. Green-top Guideline No. 34. London: RCOG; 2025.

6. Kaijser J, Vandecaveye V, Deroose CM, et al. Imaging techniques for the preoperative diagnosis of adnexal tumours. Eur Radiol. 2019; 29(6):2906–2921.

7. Meys EMJ, Jeelof LS, Achten NMJ, et al. Estimating risk of malignancy in adnexal masses: External validation of the ADNEX model. Gynecol Oncol. 2016;143(1):73–80.

8. Valentin L. Pattern recognition of pelvic masses by gray-scale ultrasound imaging: The contribution of Doppler ultrasound. Best Pract Res Clin Obstet Gynaecol. 2019; 59:44–58.

PEDAGOGICAL SCIENCES

THE USE OF CRITERION-REFERENCED ASSESSMENT IN PHYSICS LESSONS AND ITS KEY FEATURES

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Abstract

The article examines one of the main reasons for the emergence of the issue of changing or updating the system of assessing the quality of education at the present stage, namely the contradictions between changing social demands, transformations in students' cognition, and the nature of educational system management. It is argued that assessment approaches within modern innovative educational technologies cannot be effectively aligned with traditional assessment systems. Today, the requirements for assessment extend beyond merely determining students' level of knowledge; they also include the formation of personal qualities, the development of independent learning skills, the stimulation of intrinsic interest, and the enhancement of motivation to achieve success. In this context, the effectiveness of criterion-referenced assessment is emphasized. In addition, the author presents examples of criterion-referenced assessment in physics, including problem solving, oral responses, practical and laboratory work, as well as assessment based on given topics.

Keywords: criterion, descriptor, competence, competitiveness, rubric, criterion-referenced assessment, validity, reliability.

In 2015, in order to ensure the civilized development of our country, the First President, within the 13th task of the program "Modernization of Kazakhstan: 20 Steps toward a Universal Labor Society," assigned a new task to the Ministry of Education and Science of the Republic of Kazakhstan, instructing it "to expand the use of interactive forms of education in the educational process of general secondary schools starting from the 2013–2014 academic year and to introduce special curricula for online learning" [1]. All of these measures represent actions being taken to counter the impact of political and economic instability occurring in the world on our country. In addition, global globalization and the rapid development of new technologies require all countries to reconsider the field of education and to seek effective ways of delivering education. Our young state should not remain on the sidelines of this issue. The education sector is the only sphere that develops continuously and requires constant improvement. A country's economy, culture, and overall development and prosperity all depend on this education sector. Therefore, both developed and developing countries around the world pay special attention to the development of human potential and human capital. The initial source, foundation, and core of human potential development are secondary and higher education institutions. Improving the quality of education in these institutions requires the development of clear measurement criteria for assessing students' achievements. This is because assessment occupies an important place in the educational process.

Assessment plays an important role not only in the educational process but also in a person's interaction with the surrounding social environment. Finding one's place in life depends on understanding one's own capabilities. In many cases, a person's awareness of their capabilities is formed through assessment based on criteria. By developing the skill of criterion-based assessment, a learner can later apply it to finding their place in society. In short, assessment is not only an integral part of the educational process, but also a process that plays a special role in a learner's life after leaving the educational institution. Therefore, involving students in the assessment process is very important.

At the present stage of school development, the emergence of the issue of changing or updating the system for assessing the quality of education is primarily caused by contradictions between changes in social demands and changes in students' cognition, as well as the nature of management of the education system. In addition, in traditional teaching, students' level of participation in the assessment process is low, and the assessment process is carried out unilaterally by teachers. Therefore, it is well known that assessment within modern innovative educational technologies cannot be harmonized with the old assessment system. Teaching that meets the demands of the time, with the widespread use of research activities, requires a new assessment system that corresponds to current requirements. A student must learn to analyze their own work, acquire experience in reflection, and be an active participant not only in the learning process but also in

the assessment process. In this case, special attention should also be paid to self-assessment and peer assessment. Assessing one's own work is, of course, more difficult than assessing the work of others; therefore, for a child to be able to give an appropriate assessment of their own work, they must know the work standards. These standards must be written in clear language and in such a way that they can demonstrate a concrete and fair assessment. Such an opportunity can be provided only by a modern assessment system—criterion-referenced assessment.

When recalling school years, most former students first remember the grades they received, especially the "two" (failing grade). Interestingly, they often claim that this grade was given unfairly and associate it with the teacher being in a bad mood or having an improper relationship with the teacher. Likewise, the "five" (excellent grade) received by others is associated with the student being the teacher's "favorite," and that grade, too, is mentioned as having been given unfairly. Indeed, during traditional instruction, how are the grades "5" and "2" actually assigned? Who assigns them? Who can distinguish whether they are correct or objective? It is clear that everything comes down to one person—the teacher. The teacher compares the student's opinion, completed work, or oral response with their own ideal standard of work. Then the teacher begins to look for shortcomings in the student's work or response. If none are found, or if the teacher does not wish to find any, the student is given a "5"; if shortcomings are found, the grade is gradually reduced depending on their number. Sometimes, the grade is lowered or raised not based on the student's answer or solved problem, but on their behavior and conduct at school.

Many of us are well familiar with the dead silence that occurs during the break after teachers finish taking attendance and begin asking for homework, following the words "now to the blackboard…". The fear and stressful state that arise at that moment in the minds of two-thirds of children are feelings very familiar to most of us. This was undoubtedly a situation that placed emotional pressure on students. Scientists even state that such emotional stress is comparable to the overload experienced by test pilots when they first fly new aircraft [2]. What exactly did the grade given on the basis of such answers measure and evaluate? In fact, during the Soviet period, teachers themselves could not independently establish the measures or criteria for grading. Such things came from higher authorities or were sent in the form of certain templates.

If we review the literature on these issues, the system of assessing educational quality and teaching and learning outcomes is considered through the concept of "balanced assessment," which is widely used in schools in countries such as Singapore and England [3]. In traditional pedagogy, the concept of a grade is viewed one-sidedly as a qualitative indicator of the educational process. According to I. P. Podlasiy, a grade represents the relationship between actually mastered knowledge and skills and the knowledge and skills proposed for mastery [4]. According to A. K. Kolechenko, a teacher ensures a child's development at school not only through the subject content and teaching methods, but also through assessment conducted with the participation of the student [5]. This corresponds to the modern understanding of assessment in pedagogy.

It has long been known, and in recent times has been increasingly discussed and written about, that the lack of fairness, validity, authenticity, and precision in grading, as well as the fact that grading lies within the authority of only one person, often leads school instruction to place students in stressful situations. Among the reasons for this are excessive workload in the tasks given to students, the teacher's authoritarian role, the mismatch of teaching methods with students' age characteristics, and many other factors. Among these, one of the foremost issues is the subjective assessment of students' work by teachers within "traditional" instruction. An incorrectly assigned, non-objective grade affects the entire educational process. If a student easily receives an "excellent" or "good" grade, their interest in learning decreases; if they receive a poor grade that does not correspond to their actual level, they may stop studying altogether. From this, it can be observed that assessing learning outcomes is one of the most important aspects of the educational process and that assessment plays a decisive role in the learning process.

The role of "assessment" in the learning process in preserving students' health and nervous system is attracting great interest among all teachers and parents. Here, the issue is not merely about replacing the five-point grading system with a six-, eight-, ten-, or hundred-point system; rather, the core issue lies in the correct assignment of grades. No matter how fair a grade may be considered, if students themselves do not participate in the assessment process, that grade remains one-sided and raises doubts about its fairness. Therefore, great importance is being given to involving students in assessment and, through social agreement between teachers and students, conducting assessment based on specific criteria—that is, criterion-referenced assessment. At present, a results-oriented education system places special emphasis on the quality of education. In turn, improving the quality of education requires the development of clear criteria for assessing students' achievements.

At the same time, the issue here is not only students' health; the grade that is given or will be given (regardless of how high it may be) should contribute to students' further progress. This is because learning and educational achievement have never had a final limit. Therefore, when a student receives the highest grade, they should not understand this as having reached the limit of learning, nor is such a situation possible. For this reason, it is appropriate for teachers and students to openly and jointly develop assessment criteria in the classroom through mutual agreement. In traditional teaching, the main requirement of grading is to determine a student's level and position in the learning process; however, although this requirement may be necessary, it cannot be considered sufficient under current conditions. Today, the requirement for grading is not limited to determining students' knowledge level, but also includes shaping their personal qualities, fostering independent learning, stimulating intrinsic

interest, and developing motivation to achieve success. The key to competitiveness also lies here. A distinctive feature of the modern education system is that its main product is competence—that is, the development, enhancement, and formation of learners' competence for certain types of activities. We must move from assessing students' knowledge, skills, and abilities to assessing the formation of their competencies. Pedagogical technologies and the assessment system play a significant role in developing students' competencies. This, in turn, requires a developmental orientation within the assessment system. The five-point grading system inherited from the Soviet era was designed primarily to raise students' level of knowledge; today, however, not only students' knowledge is central, but also the development of their competencies, personal qualities, appropriate interaction with the surrounding environment, self-development, and independent learning. This is precisely where the inadequacy of the traditional grading system currently in use lies.

By involving students in assessment, teachers help focus their attention on learning and guide them toward more precise and purposeful actions. Assessment should provide students with information that enables self-assessment and goal setting. In this regard, assessment through criteria is highly effective. When assessment criteria are set in advance, students can evaluate their level of goal attainment independently, without teacher intervention. For example, if achieving a certain level requires fulfilling three specific criteria, a student who overlooks one of these criteria will be uncertain about having achieved the learning objective, since the three criteria confirming the intended level have not been fully met. Therefore, it is very important for students to know by what means and how they will be assessed in order to achieve the goal. By regularly providing teachers with information about what they have learned and what they have not, students gradually develop the habit of jointly developing assessment criteria together with the teacher. This habit enables them to self-assess their level of goal attainment. When students are involved in the assessment process together with the teacher, they think at a higher level, because they evaluate their own learning that is necessary for both the educational process and life experience, and they gain greater opportunities to form competencies.

Involving students in the assessment process does not mean a one-sided notion that students themselves make the final decision about what needs to be learned or what should be assessed, or that they independently determine their own level of knowledge. By participating in assessment, students use the information accumulated as a result of assessment to manage their own learning and to find answers independently to questions such as how to improve their learning, how to plan the next steps, and how to act in self-directed learning.

Through criterion-referenced assessment, students who are involved in the self-assessment process are able to identify the signs of successful learning. In this case, the teacher analyzes anonymous examples of students' strengths and the list of qualitative indicators that make them strong. At the same time, it is necessary to use evaluative frameworks to assess good work samples while explaining the pathways and conclusions for learning the qualities that lead to high achievement. By guiding students in assessment starting with one criterion and gradually expanding it to other directions, the teacher can increase the effectiveness of the process, create conditions for students to identify quality work samples, and contribute to their further development through self-evaluation of their own work. For example, students are given the opportunity to become familiar with, analyze, and evaluate sample works proposed by the teacher. They are encouraged to use criteria to improve the quality of sample works. They also learn to review and reconstruct the work sample themselves to improve it, or to provide suggestions and advice to the author of the sample work through a letter on how to improve the work. Such assessment approaches help students to revise their own work through self-support. By participating in the assessment process, students' intrinsic motivation for learning and goal orientation increase. This is because they engage in discussions with peers about their own development and share thoughts on how close they are to achieving success. They gain deeper self-knowledge, understand which material needs to be studied, and learn how to describe the quality of their own work. Criteria will not be useful unless students understand what these criteria mean in relation to their own work. Therefore, providing examples from students' work is one of the strategies for demonstrating the meaning of criteria in practice. Such examples should not be "ideal." Students learn better when they see work that is only slightly better than their current standard.

Criterion-referenced assessment is a process based on comparing students' learning achievements using clearly defined criteria that are aligned with educational goals and content, are known in advance to all participants in the educational process (students, school administration, parents, legal entities, etc.), and have been discussed collectively, thereby creating conditions for the formation of students' learning and cognitive competence [6]. A criterion is a rule, rationale, and indicator for making a decision about evaluating something in accordance with proposed requirements. Each criterion has a descriptor, which provides a clear explanation of the correctness of the outcome of performing a learning task. Assessment in accordance with the descriptor determines the extent to which a student has achieved their stated goal [6].

Table 1

Criteria for Physical Problems
(for lower grades)

№	Criteria	Descriptors	Points
1	Does not understand at all	1. Does not understand the given condition of the problem.	0
2	Remembers (satisfactory)	1. Knows which formula to use only in a memorized way.	5
		2. Cannot sufficiently understand the dependence of physical quantities on each other. 3. Does not know the units of measurement of physical quantities. 4. Makes mistakes in mathematical calculations.	
3	Understands (good)	1. Knows the units of measurement of physical quantities.	3
		2. Does not make mistakes in mathematical calculations	3
		3. Knows well which formula to use and can understand the dependence of physical quantities on each other.	4
		4. Cannot change the condition of the problem.	
4	Analyzes (very good)	1. Can complicate the problem by introducing new changes to the condition in order to deeply understand the physical phenomenon.	7
		2. Can evaluate the physical meaning of the problem.	8
Total			30

Table 2

Conversion of points into a traditional grade

Total points earned	**Grade**
0	«2»
5	«3»
5.1 – 15	«4»
15.1 – 30	«5»

Table 3

Criteria for Physical Problems

Section	**Rubrics**	**Criteria**	**Descriptors**	**Points**
A	Physics (knowledge and understanding)	1. Does not fully understand / understands the problem. Knows the units of measurement of the physical quantities given in the problem.	1. Does not understand the given condition of the problem. 2. Knows the given data of the problem and what needs to be found, but does not know which formula to use. 3. Knows which formula to use only in a memorized way. 4. Knows well which formula to use. 5. Does not know the units of measurement of physical quantities. 6. Knows the units of measurement of physical quantities.	
		2. Knows the formulas and laws necessary to solve the problem. Can derive the required formula using several laws.	1. Knows well which formula to use and the domain of its application, but cannot understand the dependence of physical quantities on each other. 2. Knows well which formula to use and can understand the dependence of physical quantities on each other. 3. Knows well which formula to use and understands the dependence of physical quantities on each other, but cannot derive the formula necessary to solve the problem. 4. Knows well which formula to use, understands the dependence of physical quantities on each other, and can derive the formula necessary to solve the problem.	

			5. Can solve a physical problem in several ways (methods, using different laws).	
		3. Explains the phenomenon by indicating the conditions under which it occurs and can change the condition of the problem.	1. Fully understands the physical meaning of the derived formulas, but does not correctly know their practical application. 2. Fully understands the physical meaning of the derived formulas and correctly knows their practical application. 3. Can construct similar problems by changing the condition of the problem. 4. Understands the interaction of bodies within a physical system with each other and with external objects, as well as the physical phenomena occurring in it.	
	Mathematics	1. Basic arithmetic operations. 2. Derivatives and differentiation. 3. Integrals.	3. 1. Even with support, the student is unable to perform basic mathematical operations. 2. The student shows limited understanding of mathematical operations and can perform them only with support. 3. The student finds an effective method for applying mathematical operations and solves them concisely. 4. The student solves a physical problem not only in the form of equations, but also using graphical or other representations.	
	Analysis	1. Can analyze the problem. 2. Can evaluate the problem. 3. Can change the conditions of the problem.	1. At the analysis stage, can answer questions about how identified physical quantities depend on other physical quantities and under what conditions these dependencies occur. 2. Can complicate the problem by introducing new changes to the condition in order to deeply understand the physical phenomenon. 3. Can evaluate the physical meaning of the problem.	

Table 4

Criteria for Assessing Oral Responses

Criteria	Descriptors	Points
Very good	a) Fully understands the physical meaning of the phenomena and laws under consideration; can prove knowledge of physical laws and theories by giving concrete examples, and can apply these laws and theories in new situations and in practical task performance.	26-30
	b) Knows precise definitions and explanations of basic concepts, laws, and theories; also knows the definitions of physical quantities, their units of measurement, and methods of measurement.	
	c) Correctly performs physical experiments, drawings, and schemes. Correctly writes formulas using the accepted system of symbols.	
	d) When answering, does not repeat the textbook text verbatim; highlights key ideas and concepts, provides justified personal opinions, and can relate new material in physics to previously studied material and to content from related subjects.	
	e) Can support the given answer with simple demonstration experiments.	
	f) Can form personal opinions, analyses, and conclusions on the given questions.	
	g) Can work independently and rationally with textbooks, supplementary literature, and reference materials.	

Good	a) Makes one minor error or no more than two overlooked points and can correct them independently or with slight assistance from the teacher.	18-25.9
	b) Has weak skills in working with reference literature (for example, can correctly find all required quantities and materials in reference sources, but works slowly).	
Satisfactory	Correctly understands the physical meaning of phenomena and laws, but when answering:	13-17.9
	a) Makes individual shortcomings in mastering key questions of the physics course that do not hinder further mastery of the curriculum material.	
	b) Experiences difficulties in solving different types of problems, explaining specific physical phenomena based on theories and laws, or applying theories to concrete practical examples.	
	c) Cannot fully answer the teacher's questions (or misses the main points), or does not sufficiently understand the essential meanings and merely repeats the content of the textbook.	
	d) When recounting the textbook text, does not sufficiently understand some important issues, or answers the teacher's questions with one or two serious errors.	
Threshold	a) Does not know or understand the basic content of the curriculum material within the scope of the questions asked.	0.1-12.9
	b) Or has weak mastery of the given material and does not fully understand it; moreover, cannot apply it to solve specific questions and tasks.	
	c) Or makes more than two serious errors in the given answer and cannot correct them even with the teacher's assistance.	
Unsatisfactory	The student cannot answer any of the questions posed.	0

Table 5

Conversion of Points into a Traditional Grade

Total points earned	Grade
0 – 12.9	«2»
13 – 17.9	«3»
18 – 25.9	«4»
26 – 30	«5»

The criteria for assessing oral responses can be used not only to evaluate how well a student has mastered the topic assigned as homework, but also to clarify and assess a student's knowledge in various written tasks (scientific-research work, control and test problem solving, or laboratory work).

Table 6

Criteria for Assessing Practical and Laboratory Work

Criteria	Descriptors	Points
Very good	Performs measurements and experiments in full, observing the required sequence.	26-30
	Independently and consciously selects and prepares all equipment required for the experiment; all experiments are conducted under conditions that ensure high accuracy of the obtained results and conclusions.	
	All records, tables, drawings, diagrams, graphs, calculations, and conclusions are completed very neatly.	
	Correctly performs error analysis.	
	Fully complies with safety regulations.	
Good	Meets the requirements of the "Very good" criteria, and additionally the following conditions are met.	18-25.9
	The experiment is not conducted under conditions that fully ensure the required accuracy.	
	If 2–3 remarks are given, or one serious error and one remark are given.	

Satisfactory	Corresponds to the "Satisfactory" criterion if the work is not fully completed, but conclusions can be drawn from the completed part of the work, or if the following errors are made during measurements and experiments.	13-17.9
	Significant errors occur in the obtained results due to conducting the experiment in an unclear (irrational) manner.	
	If no more than two errors in total are made in calculations (in units in records, measurements, calculations, graphs, tables, diagrams, error analysis, etc.), and these errors are of an unclear nature but do not affect the final result of the work.	
	Error analysis is performed incorrectly or not performed at all.	
	The work is not fully completed, but the completed part allows correct results and conclusions to be drawn about the main, fundamental tasks of the work.	
Threshold	The work is not fully completed, and correct conclusions cannot be drawn from the completed part.	0.1-12.9
	Experiments, measurements, calculations, and observations are not performed correctly.	
	Several of the deficiency requirements specified for the "Satisfactory" criterion occur during the work and in the report.	
Unsatisfactory	The work is not completed, and correct conclusions cannot be drawn from the completed part.	0
	Experiments, measurements, calculations, and observations are not performed correctly.	
	Several of the deficiency requirements specified for the grade "3" occur during the work and in the report.	

If a student completes the work in an exemplary manner and approaches the performance of the work thoughtfully during the process, but nevertheless makes certain shortcomings, the teacher has the opportunity to assign a grade higher than the established norm.

The use of criterion-referenced assessment on the topic "Measuring the Capacitive Reactance of a Capacitor in an Alternating Current Circuit" [7].

Purpose of criterion-referenced assessment:

- not to evaluate only whether the student has completed the task and calculated correctly, but to assess the student's understanding of the topic "Measuring the Capacitive Reactance of a Capacitor in an Alternating Current Circuit" and their ability to apply knowledge gained from the laws of alternating current circuits to the acquisition of new knowledge;
- through this assessment, students can identify gaps in their knowledge and strive to achieve greater success in mastering the topic "Electromagnetic Oscillations";
- to form students' ability for self-assessment and to enable deep understanding of the material provided during the work process;
- to allow students to determine their level of mastery, the degree they have reached, and how they can move forward.

Table 7

Criterion		**Highest level of students' knowledge**
C	Scientific-level knowledge and understanding	10
D	Scientific research methods and conducting experiments	10
E	Information analysis	10

Criterion	**Students' level of knowledge**	**Descriptors**
C (max 10)	0	The student has not mastered any of the criteria listed below.
	1-2	From the topic "Alternating Electric Current," the student can answer general questions, but cannot understand the full physical meaning.
	3-4	From the topic "Alternating Electric Current," the student can answer general questions, but cannot understand the interdependence of some physical quantities.
	5-6	From the topic "Alternating Electric Current," the student can answer general questions and fully understands the physical meaning, but does not correctly know its practical application.

	7-8	The student can correctly analyze and compare, and can identify the role of physical quantities in this process, but cannot present them properly.
	9-10	The student can fully (explain) the topic. Can work independently at a scientific level. Has good command of physical instruments and can conduct experiments.
D (max 10)	0	The student has not mastered any of the criteria listed below.
	1-2	The student could not fully complete the work because they do not know some physical laws.
	3-4	The student knows physical laws, but could not complete the work correctly because they could not properly distinguish physical quantities.
	5-6	The student knows physical laws and physical quantities, but could not apply them during the experiment.
	7-8	The student has fully mastered the topic "Alternating Electric Current," but during the experimental work could not correctly reveal some physical processes.
	9-10	The student has fully mastered the topic "Alternating Electric Current," correctly performed the experimental work, and fully demonstrated the physical process. Knows how the knowledge gained in determining the capacitance of a capacitor in an alternating current circuit can be used in future scientific work.
E (max 10)	0	The student has not mastered any of the criteria listed below.
	1-2	While performing the work, the student could not understand the readings of the instruments. The calculation results are incorrect. Does not know the units of physical quantities (ν, Im, Um, C, Xc).
	3-4	While performing the work, the student correctly records the instrument readings, but cannot use the formulas from the topic "Alternating Electric Current."
	5-6	While performing the work, the student correctly records the instrument readings and uses the formulas from the topic "Alternating Electric Current," but makes a mathematical error in the calculations.
	7-8	While performing the work, the student correctly records the instrument readings, correctly performs the calculations using formulas from the topic "Alternating Electric Current," but cannot explain them properly.
	9-10	While performing the work, the student correctly records the instrument readings, correctly performs the calculations using formulas from the topic "Alternating Electric Current," and explains them correctly.

Table 8

Conversion of Scores into a Traditional Grade

Total points earned	Grade
0 – 12.9	«2»
13 – 17.9	«3»
18 – 25.9	«4»
26 – 30	«5»

Table 9

Criteria for Assessing Control and Independent Written Work

Criteria	Descriptors	Points
Very good	Assigned for work completed without errors and without remarks.	26 – 30
Good	The work is fully completed, but: a) one non-serious error and one remark are present, b) or two remarks are present.	18 – 25.9
Satisfactory	If the student correctly completes half of the work, or if: a) the number of serious errors does not exceed two, b) the number of serious errors and remarks does not exceed one, c) the number of serious errors does not exceed two or three, d) there is one serious error and no more than three remarks, e) there are no serious errors, but 4–5 remarks are present.	13 – 17.9
Threshold	If the number of serious errors and remarks exceeds the norm set for the "Satisfactory" criterion, or if less than half of the work is completed correctly.	0.1 – 12.9
Unsatisfactory	The student does not begin the work or completes only 10% of the given task, that is, writes the condition of the task using generally accepted symbolic notation.	0

A teacher may assign a grade higher than the established "norm" if the student's completed work is exemplary.

Table 10

Conversion of Scores into a Traditional Grade

Total points earned	Grade
0 – 12.9	«2»
13 – 17.9	«3»
18 – 25.9	«4»
26 – 30	«5»

The following are considered serious (gross) errors:

- lack of knowledge of basic concepts, laws, rules, fundamental theories, formulas, symbols denoting physical quantities, and their units of measurement;
- lack of knowledge of the names of units of measurement;
- inability to identify the main idea in an answer;
- inability to apply one's knowledge to solving problems and explaining physical phenomena;
- inability to summarize and generalize the work;
- inability to construct and read schematic diagrams and graphs;
- inability to prepare equipment or a physical apparatus, inability to conduct experiments, incorrect calculations, or inability to draw conclusions from the obtained results;
- inability to work with textbooks or reference materials in physics and technology;
- violation of technical safety rules during physical experiments;
- careless handling of laboratory equipment and measuring instruments.

Non-serious (minor) errors include:

- formulations, definitions, concepts, laws, and theories do not fully cover the essential characteristics of the defined concepts; lack of precision;
- errors made when recording readings of measuring instruments, not related to determining the value of a scale division;
- errors arising from failure to observe the operating conditions of experiments and measuring instruments (e.g., incorrect positioning of scales, incorrect choice of reference system);
- errors caused by inaccuracies in conventional symbols in schematic diagrams and in graphs;
- poorly thought-out methods of solving tasks or insufficiently planned oral responses (violation of logic, replacement of main questions with secondary ones);
- lack of accuracy in methods of working with reference and other literature, inability to solve a problem in a general form.

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References

1. Nazarbayev, N. Innovations and the improvement of education toward a knowledge-based economy. – Egemen Kazakhstan, 27 May 2006.

2. Krasnoborova, A. A. Criterion-based assessment in school: a study guide. – Perm, 2010. (Criterion-based assessment at school: study guide).

3. "Academic Assessment Workshop" seminar materials. Singapore, March 2014.

4. Podlasiy, I. P. Pedagogy: a textbook for higher education institutions. – Moscow, 1999. (Textbook for higher education institutions).

5. Kolechenko, A. K. Encyclopedia of pedagogical technologies: a guide for teachers. – St. Petersburg: KARO, 2002. – 368 p. (Guide for teachers: encyclopedia of pedagogical technologies).

6. Program of professional development courses for pedagogical staff of the Republic of Kazakhstan. Third (basic) level, second edition. – Astana, 2012.

7. Materials of online physics lessons. Nazarbayev Intellectual Schools (NIS). – Astana, 2011.

THE USE OF DIDACTIC GAMES IN CHEMISTRY EDUCATION

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ИСПОЛЬЗОВАНИЕ ДИДАКТИЧЕСКИХ ИГР В ОБУЧЕНИИ ХИМИИ

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Abstract

The article explores the importance of didactic games as an effective tool for enhancing learners' cognitive engagement. It outlines the key functions and principles of integrating didactic games into the educational process and highlights their role in fostering sustained interest in learning. The paper presents examples of the application of game-based methodologies at different stages of education, identifies the pedagogical conditions necessary for their successful implementation, and analyzes the influence of game-based technologies on the development of students' creative and communicative skills. Particular attention is given to strategies for adapting didactic games to learners' age-related and individual characteristics.

Аннотация

В статье рассматривается значение дидактических игр как эффективного средства активизации познавательной деятельности обучающихся. Раскрываются основные функции и принципы использования дидактических игр в образовательном процессе, а также их роль в формировании устойчивого интереса к обучению. Приводятся примеры применения игровых методик на различных этапах обучения, определяются педагогические условия их успешного внедрения, анализируется влияние игровых технологий на развитие творческих и коммуникативных способностей учащихся. Особое внимание уделяется вопросам адаптации дидактических игр с учетом возрастных и индивидуальных особенностей детей.

Keywords: didactic games, learning, motivation, cognitive engagement, game-based learning, pedagogical technologies.

Ключевые слова: дидактические игры, обучение, мотивация, активизация познавательной деятельности, игровой метод, педагогические технологии.

В условиях современного этапа, характеризующегося быстрым развитием производственных технологий, сфера образования, как и другие отрасли производства, все более совершенствуется как область, основанная на научно обоснованных новых педагогических технологиях и использовании информационных ресурсов, обеспечивающих подготовку конкурентоспособных, высококвалифицированных, образованных и интеллектуально развитых специалистов, способных эффективно осуществлять профессиональную деятельность во благо процветания Родины [1].

Одной из важнейших задач современного образования является удовлетворение потребности личности обучающегося в получении знаний. Вопрос «Кого мы должны воспитывать?» стал одной из ключевых проблем современной педагогики, дидактики и методики преподавания учебных дисциплин.

Одним из ключевых требований, предъявляемых к современному уроку, являются дидактические требования, включающие чёткое и научно обоснованное определение образовательных и воспитательных целей занятия, обеспечение активного и осознанного участия всех обучающихся в учебном процессе, рациональный выбор методов и приёмов обучения в соответствии с содержанием изучаемой темы, а также ряд других организационно-методических условий [2].

Преподаватель любого учебного предмета должен в полной мере владеть дидактическими основами преподаваемой дисциплины, знать и эффективно применять общие методы обучения, учитывать особенности мышления обучающихся, а также обладать достаточным педагогическим и жизненным опытом. В особенности при обучении химии использование различных

интеллектуальных заданий, головоломок, связанных с химическими терминами и специальными понятиями, способствует формированию у учащихся сообразительности, быстроты мышления и познавательной активности. Подобные формы работы стимулируют обучающихся к самостоятельной деятельности, стремлению к углублённому усвоению знаний и рациональному использованию возможностей химической науки [2].

С целью развития мышления учащихся, постоянной активизации учебного процесса и повышения их активности в процессе усвоения знаний целесообразно закреплять материал с помощью выполнения специально подобранных головоломок. Эти упражнения способствуют формированию логического мышления, развивают внимание и смекалку, а также стимулируют самостоятельную работу и углубленное понимание изучаемой темы.

Правильное выполнение предложенных вопросов и последующее размещение первых букв ответов в указанных пустых клетках позволяет студентам получить мудрую фразу, которая надолго напоминает о том, что органическая химия является одной из могущественных и значимых наук о природе. Например, формироваться фраза: «Органическая химия — это страна чудес», которая привлекает студентов в увлекательный и прекрасный мир органической химии.

1. Восьмой представитель алканов, 2. Химический процесс, 3. Остаток, получаемый из нефти, 4. Ароматическое аминное соединение, 5. Сложный эфир глицерина, 6. Насыщенный углеводород, используемый для определения октанового числа бензина, 7. Активированный уголь, органическое углеродное соединение, 8. Известный химик-органик, занимался изучением органических соединений и полимеров, 9. Природный углевод, широко используется в пищевой промышленности, 10. Вещество, влияющее на скорость реакции, 11. Бесцветный горючий газ, 12. Органическое соединение, представляющее собой двухосновную предельную карбоновую кислоту, 13. Органическое галогенированное соединение, используется как растворитель и в лабораторных реакциях, 14. Вещество, полностью замедляющее скорость реакции, 15. Остаток после отгонки из нефти легких фракций, 16. Органический краситель, используемый с древних времён, 17. Органическая кислота, которые используется в пищевой промышленности и биохимии, 18. Органическое соединение, которые используется в органическом синтезе и для дезинфекции, 19. Органическое соединение, алкалоид, содержится в шоколаде, 20. Соли и эфиры щавелевой кислоты, 21. Производная бензола, дающая полимерные продукты, 22. Одна из 20 стандартных аминокислот, входящих в состав белков, 23. Углевод, входящий в состав нуклеиновых кислот, 24. Органическое соединение, относящееся к классу антрахиноновых красителей, 25. Природная смесь различных углеводородов, 26. простейший ароматический амин, сырье для производства красителей и лекарств, 27. Химик, занимался координационными соединениями и органическим синтезом, 28. Органическое соединение, используется в полимерной промышленности, 29. Водорастворимое органическое вещество, получаемое из крахмала, 30. Углеводороды, содержащие в молекуле одновременно и двойную, и тройную связи используется в пищевой промышленности, клеевых составах и органическом синтезе, 31. Насыщенная жирная кислота, применяется в производстве мыла и косметики.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	-
о	р	г	а	н	и	ч	е	с	к	а	я	х	и	м	и	я	-

18	19	20	21	22	23	24	25	26	27	28	29	30	31
э	т	о	с	т	р	а	н	а	ч	у	д	е	С

1. Октан, 2. Реакция, 3. Гудрон, 4. Анилин, 5. Нитроглицерин, 6. Изооктан, 7. Чаркол, 8. Ефремов, 9. Сахароза, 10. Катализатор, 11. Ацетилен, 12 Янтарная кислота, 13.

Хлороформ, 14. Ингибитор. 15. Мазут, 16. Индиго, 17. Яблочная кислота**,** 18. Этанол**, 19.** Теобромин**, 20.** Оксалаты, 21. Стирол**, 22.** Тирозин, 23. Рибоза**, 24.** Ализарин**, 25.** Нефть**, 26.** Анилин, 27. Чугаев, 28. Уретан, 29. Декстрин**, 30.** Енины, 31. Стеариновая кислота

Подобные мероприятия могут проводиться как на уроке, так и вне класса и школы. Они развивают логическое мышление учащихся, обогащают их словарный запас и стимулируют самостоятельное и индивидуальное мышление.

Таким образом, интерактивные методы и занятия в форме вопрос-ответ играют важную роль в развитии логического мышления учащихся, обогащении их словарного запаса и формировании навыков самостоятельного мышления. Такие игры и мероприятия могут проводиться как на уроках, так и вне класса и школы, что делает образовательный процесс более интересным и эффективным. Можно сделать вывод, что данный подход не только способствует глубокому пониманию содержания предметов, но и развивает у учащихся научное мышление, творческий подход и способность к самостоятельным исследованиям. Эти методы в современном образовательном процессе повышают значимость таких предметов, как органическая химия, и превращают их в источник научного интереса.

Литература

1. Likhanov V. O. *Modern Pedagogical Technologies, Innovative Forms and Methods of Teaching //* **International Journal of Artificial Intelligence**. — 2025. — Vol. 5, № 12. — P. 2398-2401.

2. Карасик В. И. **Дидактика: теория и практика.** — М.: Просвещение, 2019. — 432 с.

3. Davronova F. *Didactic and Pedagogical Foundations of Teaching Chemistry Using Simulation Models* // Acta NUUz. - 2024.

PHILOLOGICAL SCIENCES

COLORISTICS AS AN OBJECT OF LINGUISTIC RESEARCH

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КОЛОРИСТИКА КАК ОБЪЕКТ ЛИНГВИСТИЧЕСКИХ ИССЛЕДОВАНИЙ

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Abstract

This paper examines contemporary linguistic approaches to the study of color designations within the cognitive and linguacultural paradigms. It explores the role of color as a key category of sensory perception, thought, and culture in the formation of conceptual and linguistic worldviews. It also analyzes the main classifications and areas of research into coloristic vocabulary, its nominative, symbolic, and emotionally expressive functions, as well as the specific features of color designations in literary texts, where they serve as an important element of the author's idiostyle and a means of reflecting national-cultural specificity and individual worldview.

Аннотация

В работе рассматриваются современные лингвистические подходы к изучению цветообозначений в рамках когнитивной и лингвокультурологической парадигм, раскрывается роль цвета как ключевой категории чувственного восприятия, мышления и культуры в формировании концептуальной и языковой картин мира; анализируются основные классификации и направления исследования колористической лексики, её номинативные, символические и эмоционально-экспрессивные функции, а также особенности функционирования цветообозначений в художественном тексте, где они выступают важным элементом идиостиля автора и средством отражения национально-культурной специфики и индивидуального мировосприятия.

Keywords: linguistic picture of the world, color designations, coloristic vocabulary, linguacultural studies, cognitive linguistics.

Ключевые слова: языковая картина мира, цветообозначения, колористическая лексика, лингвокультурология, когнитивная лингвистика.

Современные лингвистические исследования рассматривают языковые явления через призму человеческого сознания, мышления и практической деятельности. Учёных интересует, как человек с помощью языка передаёт свои знания о мире, полученные в процессе наблюдений и практического опыта. Язык позволяет отражать то, как человек воспринимает окружающую действительность, как осознает и классифицирует её. Особое внимание при этом уделяется роли чувственного восприятия в формировании представлений о мире.

По мнению когнитивистов, изучение способов, с помощью которых люди выражают концепты и категории, показывающие их взгляд на мир, даёт наиболее надёжную информацию о структуре человеческого мышления. Через язык происходит обработка и систематизация сенсорных данных, выделение особенностей объектов, сравнение их друг с другом, а также выявление связей между ними. Таким образом, язык выступает не только средством общения, но и инструментом организации, хранения и передачи знаний, отражая весь опыт познания человеком окружающего мира. [11]

Большая часть сведений об окружающем мире поступает к нам через цветовое восприятие. С древних времён цвет использовался во множестве ремёсел. Применение цвета охватывало различные сферы, а его изучение привлекало внимание науки. Благодаря этому современная наука обладает обширными знаниями о цвете из физики, оптики, физиологии и теории восприятия. По этой причине при исследовании цвета в лингвистике учёные активно используют термины и концепции, которые заимствуются из данных дисциплин и опираются на исследования о цвете из смежных областей.

Поскольку современная лингвокультурология изучает культурную семантику языковых знаков, формирующихся на стыке двух кодов — языка и культуры, обозначения цветов могут выступать как своего рода язык культуры. Они проявляются в способности языка отражать культурно-

национальный менталитет носителей, их ценностные ориентиры, а также фиксировать изменения этих ориентиров в разные исторические периоды. Прилагательные, которые называют цвета, отражают долгий период развития культурных традиций народа, сохраняют культурные нормы, символику, стереотипы, эталоны и передают их из поколения в поколение. [15]

Цвет – одна из ключевых категорий культуры, поскольку в нем сохраняется уникальная информация о колорите природы, особенности развития человечества, взаимодействия различных этнических культур и характере художественного восприятия мира. Цвет, будучи частью культуры, окружён множеством ассоциаций, смысловых оттенков и интерпретаций, отражая разнообразие нравственных и эстетических ценностей. С помощью цвета можно передавать эмоции, обогащённые многочисленными ассоциациями, закреплёнными в языке и социокультурной практике. Через цвет человек выражает своё отношение к окружающему миру. [11]

Несмотря на тесную связь цветообозначений с культурой и историческим наследием, они являются культурными артефактами. Поэтому цветовая картина мира, будучи важной частью ЯКМ, также отражает эти культурные особенности. Исследования показывают наличие у многих языков схожей системы цветообозначений. В этих системах выделяются универсальные черты, отсутствующие у других языков. При этом отношение к определённым оттенкам проявляется в образных средствах языка - выражениях, идиомах и поговорках, которые раскрывают национальный колорит языка.

Одна из ключевых задач филологии - осмысление онтологического положения человека в мире и формирование целостного восприятия окружающей действительности во всей её полноте. В современной культуре это восприятие часто обозначается термином «картина мира» (КМ). Значительную роль в её создании играет онтология — раздел философии, изучающий бытие и закладывающий основы картины мира на базе общих принципов познания, характерных для определённой философской традиции. [8]

Термин «картина мира» впервые был введён в научный оборот немецким физиком Генрихом Герцем для обозначения всего многообразия представлений о внешнем мире, которые вырабатывались различными исследователями. «Картина мира» представляет собой систему интуитивных представлений о действительности. Она может быть выделена, описана или реконструирована для любой социопсихологической единицы — от нации или этноса до социальной, профессиональной группы или отдельной личности. Под КМ понимается совокупность представлений о структуре и законах функционирования действительности, которая сложилась на определённом этапе человеческого развития. Она основывается на исходных мировоззренческих принципах и объединяет накопленные знания и опыт. КМ отражает воспринимаемую реальность, доступную всем органам чувств — человек видит, слышит, ощущает и осмысливает её.

Современные исследования изучают, как человек воспринимает объективную реальность и взаимодействует с ней, опираясь на два ключевых понятия: концептуальная картина мира (ККМ) и языковая картина мира (ЯКМ).

Основной элемент концептуальной картины мира — концепт - единица ментальной системы, памяти и концептуальной структуры, которая представляет собой «квант» знаний, который включает жизненный опыт человека, его представления о реальности и результаты познавательной и практической деятельности. ККМ охватывает также культурную картину мира, уникальную для каждого народа, отражающую действительность через призму понятий, которые сформированы на основе сенсорного восприятия и обработанных сознанием на индивидуальном и на коллективном уровне.

Цветовая картина мира является составной частью культурной и концептуальной картин. Значения цвета могут различаться у разных этнических групп, народов и отдельных личностей. Лингвоцветовая картина мира проявляется в словах, выражениях и идиомах, тесно переплетаясь с лексикой и становясь частью языковой картины мира. [15]

Языковая картина мира (ЯКМ) формируется на основе многовекового опыта народа и отражает восприятие мира как целостной и многогранной системы через языковые номинации. Различные аспекты окружающей действительности находят своё выражение в лексическом значении слов. Хотя понятия объективной реальности имеют универсальный характер, их выражение в словах обладает национальной спецификой. Каждое понятие может проявляться через разные признаки.

Согласно Н.Ф. Алефиренко, «языковая картина мира» отражает действительность с помощью языковых средств, формируя наглядное представление о предметах и явлениях. Таким образом, ЯКМ представляет собой языковое воспроизведение окружающего мира. Картина предполагает целостное отображение объектов и явлений, фиксируя их состояние и положение. Она отражает элементы в разных состояниях и связях, демонстрируя разнообразие и единство мира, а также указывая на составные части картины и их взаимное расположение.

Современные исследования свидетельствуют о том, что при нормальных условиях человеческий глаз способен различать от двадцати до двухсот тысяч цветовых оттенков. Вместе с тем язык и понятийная система не в состоянии зафиксировать всё это многообразие, поскольку для обозначения каждого оттенка не существует отдельного наименования. Даже названия некоторых основных цветов имеют не прямое, а ассоциативное происхождение: так, слово «красный» связано с понятием «краса», «жёлтый» — с «желчью», а

«оранжевый» заимствовано из английского orange («апельсин»).

Большинство дополнительных оттенков не обладают самостоятельными наименованиями и обозначаются либо ассоциативным способом (малиновый, салатовый, кирпичный, сиреневый), либо описательно (тёмно-зелёный, светло-жёлтый и др.). Вследствие невозможности вербализации многих оттенков их полное осмысление оказывается затруднённым, а значительная часть информации о богатстве цветового спектра остаётся на уровне подсознательного восприятия.

Это наблюдение подчёркивает важнейшую роль языка в формировании картины мира: то, что не получило языковой номинации, как бы не существует для сознания. Однако предложенная классификация номинаций требует уточнения. Среди ассоциативных названий целесообразно выделять этимологические, неосознаваемые современными носителями языка (например, жёлтый — «цвет желчи»), и актуальные, осознаваемые в настоящее время (сиреневый, малиновый, болотный и др.). Вероятно, изначально все цветовые названия имели ассоциативную природу, поскольку обозначение цвета — это особая абстракция, которая в древности опиралась на конкретные природные оттенки. При этом не каждый хроматоним поддаётся этимологическому анализу из-за давности происхождения.

На рубеже XIX–XX веков филология достигла заметных успехов в определении значения цвета и его символической функции. В символизме цвет занимал главенствующую роль, а семантическое поле цвета стало одной из наиболее чётко структурированных категорий, активно используемой в научных целях. Большинство исследователей признают совокупность цветообозначений именно семантическим полем.

В настоящее время не существует единой общепринятой классификации цветов. Ряд исследователей выделяет три базовых цвета, присутствующих в природе: красный, синий и зелёный. А. М. Танабаева и Ф. Ш. Оразгалиева предлагают классификацию цветообозначений, включающую три группы: основные (чистые) цвета — красный и синий; оттеночные — например, светло-зелёный, тёмно-красный; специализированные — цвета, используемые для обозначения волос, глаз и кожи человека, а также масти животных.

Колоративная лексика объединяет слова, называющие цвет. Под колоризмом понимается языковая единица, содержащая корневой морф, связанный с наименованием цвета. Одним из направлений изучения колористической лексики является анализ эмоционального восприятия различных цветов носителями разных языков, а также исследование гендерных особенностей в этой области. Следует отметить, что интерес к колористической лексике существует с античных времён. Значительное внимание ей уделялось в рамках теории лингвистической относительности, при изучении языковой картины мира и семантики слов. В настоящее время эта группа лексики считается достаточно хорошо изученной в отношении европейских языков: выделены национальные колористические триады, проанализировано творчество многих писателей с позиции цветовых значений, а также начаты исследования цветообозначений с учётом гендерного аспекта.

Колоративы — это одна из разновидностей лексических универсалий, представляющая собой группу прилагательных, которые обозначают цвета. Эта лексическая группа не является закрытой, однако обычно не наблюдается яркой тенденции к её расширению. Внутри колоративов различают собственно колоративы (например, красный, синий, коралловый) и дополнительные характеристики цвета (светлый, тёмный). [6]

Колоризмы в произведениях любого автора являются частью его мировосприятия и, как следствие, составляют элемент идиостиля. Отбирая определённый набор колоризмов, писатель формирует индивидуальную цветовую картину мира. Каждый колоризм занимает своё место в тексте, способствуя целостному восприятию художественного пространства произведения. Особенности употребления колоризмов, отражающих объективную реальность, выступают показателем индивидуального авторского письма и специфики его мировидения.

В смысловой организации текста колоризмы могут выступать как символические единицы, а в его структуре — выполнять текстообразующую функцию. Таким образом, цветовая лексика способна приобретать концептуальное значение, помогая глубже раскрывать внутренний мир персонажей и осмысливать художественную реальность.

Художественный текст - это целостное эстетическое пространство, в котором колоризмы являются одним из значимых компонентов. Анализ цветовых впечатлений предполагает изучение всех языковых средств, используемых для обозначения цвета, включая семантику наименований оттенков и цветовых сочетаний, а также их соотнесённость с традиционными символическими значениями в данной этнокультуре или их авторскую трансформацию [12].

Отдельное направление исследований посвящено анализу цветообозначений в художественных текстах. В его рамках изучаются функции цветовой лексики, её символика у различных писателей, особенности авторской цветовой палитры, а также проблемы перевода цветообозначений. Лингвистика стремится выявить особенности функционирования слов-цветообозначений в языке и различных стилях речи, проследить их развитие в разных языках и раскрыть дополнительные смысловые оттенки на материале художественной литературы. В литературном тексте цвет не только отражает отношение к объектам действительности, но и служит средством выражения внутреннего мира автора и эмоциональных переживаний его персонажей [16].

Актуальность исследований стилистики колористической лексики очевидна. Ученые показывают, что цветообозначения играют важную роль в раскрытии авторской идеи, создании образов персонажей и формировании эмоциональной атмосферы произведения.

Цветопись в художественных произведениях не ограничивается лишь бытовыми описаниями. Она передает мысли, чувства и переживания персонажей, оценивает события и выступает средством художественной выразительности. Цветообозначения входят в состав эпитетов, метафор, сравнений, метонимий и сюжетных символов.

Эпитеты с цветовой компонентой являются одним из самых часто используемых стилистических приёмов. Они помогают передать оттенки цвета, например: «жемчужные зубы», «сапфировый взгляд», «дымчато-серый цвет лица». В поэзии можно встретить многочисленные цветовые эпитеты, которые обогащают речь и придают ей эмоциональную окраску: мертвенно-свинцовым, бледно-розовый, странно-синий.

Сравнения также часто используют цветовую составляющую. В литературном произведении исследователи выделяют следующие типы сравнения: с использованием слов-связок как, словно, точно, будто, сравнительной степени прилагательных или конструкции с союзом как: В прозе нередко используются синтаксические структуры без сравнительных оборотов (цвет слоновой кости, цвет янтаря).

Метафоры, включающие цветообозначения, занимают особое место в художественной выразительности. Лексика, не имеющая изначального значения цвета, может приобретать его в контексте, дополняя собственное семантическое содержание.

Таким образом, прямые указания на цвет выполняют номинативную функцию, описывают ситуации, события или предметы, помогают обозначить время, место действия и создают фон произведения. Цветообозначения в художественном тексте имеют важное значение, поскольку способствуют раскрытию психологизма персонажей и общей атмосферы произведения.

Основу когнитивной теории А. Вежбицкой составляет идея связи цвета с его эталонным носителем: цвета в языке не существуют абстрактно, а привязаны к конкретным объектам, важными для человека, и ассоциируются с ними. Сопоставление физического значения цвета (его спектральных характеристик) с концептом и эталонным носителем позволяет определить семантическое поле цвета. Оно может различаться у разных народов и быть индивидуально субъективным. [5]

В лингвистике изучение цветообозначений ведётся по нескольким направлениям. Современные исследования выделяют шесть ключевых подходов: функциональный, исторический, лексико-семантический, грамматический, когнитивный и сопоставительный.

Функциональный подход изучает роль цветообозначений в художественных текстах, где цвет является элементом индивидуального стиля писателя, помогает раскрывать замысел произведения, создавать эмоциональную атмосферу и формировать образы персонажей. Цветовые слова рассматриваются как средства усиления выразительности речи и соотносятся с тропами и стилистическими фигурами, актуализирующими прагматику высказывания.

Исторический подход сосредоточен на происхождении слов, обозначающих цвета, процессах формирования цветовой лексики и её составе на разных этапах развития языка. Исследуется семантический первоэлемент, помогающий реконструировать историю значений цветовых слов, что важно для концептуальных исследований.

Лексико-семантический подход анализирует современную систему цветообозначений, изменения в семантической структуре лексики, развитие образных и символических значений, формирование лексико-семантических групп и использование слов в прямом и переносном смысле.

Грамматический подход рассматривает морфологические и синтаксические особенности цветообозначений, что помогает выявить их образную функцию в речи.

Когнитивный подход изучает ментальное восприятие цвета, его психологическое и концептуальное осмысление.

Сопоставительный подход позволяет выявлять сходства и различия в спектрах цветовых обозначений разных языков, изучать национально-культурную окраску цветовых слов и модели восприятия действительности, характерные для каждого языка. Этот подход является продолжением когнитивного и актуален в контексте межкультурного взаимодействия [15].

Лингвисты различают два типа цветообозначений: основные (абсолютные) и оттеночные. Основные включают хроматические (красный, оранжевый, жёлтый) и ахроматические (чёрный, белый, серый). Остальные цвета являются оттеночными. Они могут быть аналитическими (сиреневый, молочный), заимствованными (беж), неологизмами или архаизмами (тиффани, смарагдовый), терминологическими (охра) и окказиональными.

Сложные и уточняющие оттенки формируются с помощью формантов, указывающих на интенсивность (ярко-, светло-, темно-), двусоставных конструкций (жёлто-синий), генитивных выражений («цвета морской волны») и сравнительных оборотов («бело как снег») [16].

А А. А. Брагина подчёркивает, что один из способов «приращения смысла» у цветообозначений — полисемия, переносные значения и метафоризация. Переносные значения возникают через непрямую номинацию, зависят от контекста и часто сопровождаются стилистическими или экспрессивно-оценочными оттенками. Несмотря на вариативность,

доминирующее значение сохраняется, создавая многоплановость толкования. Прямое значение может порождать переносное, либо значение, не связанное с цветом, становится источником цветового переносного значения [4].

Н. Б. Бахилина отмечает, что формирование лексико-семантической группы цветообозначений связано с развитием письменности и первых летописей. Древнерусские тексты содержат ограниченные сведения о цветовой лексике, включавшей только основные природные цвета: белый, чёрный, красный, синий, жёлтый и зелёный [3].

В работе Б. Берлина и П. Кея «Базовые цветонаименования: их универсальность и эволюция» подчеркивается, что цвет — семантическая универсалия, а цветообозначения индоевропейских языков описываются тремя свойствами: тон, яркость и насыщенность. Основная единица — базисный цветовой термин, количество которых ограничено. Цветовые понятия развиваются стадийно: сначала появляются белый и чёрный, затем красный, после — синий, зелёный и жёлтый, на завершающих стадиях — коричневый, розовый, оранжевый, фиолетовый и серый [19].

Э. Рош вводит понятие «прототип» цветообозначений — типичный представитель категории, отражающий её основные характеристики (например, изумрудный — «типичный зелёный», салатовый — «другой оттенок зелёного») [20].

В. И. Иваровская выделяет десять основных цветов: белый, красный, синий, зелёный, жёлтый, коричневый, серый, чёрный, оранжевый и фиолетовый, рассматривая мотивированность и немотивированность цветообозначений [10].

Р. М. Фрумкина отмечает, что наивная картина мира русского языка включает семь цветов радуги, розовый, коричневый и ахроматические цвета как основные, остальные оттенки относятся к «прочим».

Е. А. Косых анализирует цветообозначения через прилагательные: монолексемные, сложные с двумя или тремя корнями, конструкции «существительное + цвет», а также комбинации существительного и прилагательного [13].

Ю. Д. Апресян делит цветовые прилагательные по принципу предельности: середина спектра соответствует максимально выраженному цвету, отклонения — переходу к соседним оттенкам [2].

Таким образом, цветообозначения занимают значимое место в языковой картине мира, поскольку отражают особенности чувственного восприятия, когнитивной деятельности и культурного опыта человека. Через систему цветонаименований язык структурирует знания об окружающей действительности, фиксируя как универсальные, так и национально-специфические представления о мире.

Особую роль колористическая лексика играет в художественных текстах, где цвет становится средством образности, символизации и эмоционального воздействия. Анализ цветообозначений позволяет глубже понять авторскую картину мира, специфику идиостиля и механизмы языкового выражения культурных и психологических смыслов.

Список источников

1. Алефиренко Н.Ф. Лингвокультурология. Ценностно-смысловое пространство языка. — М.: Флинта, Наука, 2010. — 224 с.

2. Апресян Ю. Д. Избранные труды. Том I. Лексическая семантика. — Москва: Языки русской культуры, 1995. — 480 с.

3. Бахилина Н.Б. История цветообозначений в русском языке. — М.: Наука, 1975. — 288 с.

4. Брагина А.А. Цветовые определения и формирование новых значений слов и словосочетаний // Лексикология и лексикография. — М., 1972. — С. 73–104.

5. Вежбицкая А. Обозначения цвета и универсалии зрительного восприятия // Язык. Культура. Познание. — М., 1996. — С. 231–291.

6. Гекман М. Л. Цветообозначения как один из объектов исследования этнолингвистики. — Караганда: Карагандинский государственный университет им. Е. А. Букетова, 2007. — 15 с.

7. Гёте И. В. Учение о цвете / пер. с нем. В. Лихтенштадта. — СПб.: Азбука, Азбука-Аттикус, 2019. — 252 с.

8. Гладкова Е. С. Коннотация цветообозначений в английском и русском языках: лингвокультурологический анализ: дис. — Ишим, 2016. — 81 с.

9. Гладкова Е. С. Лингвокультурный аспект цветообозначений // Молодой ученый. — 2016. — № 19 (123). — С. 553–556.

10. Иваровская В. М. Синтагматико-парадигматические особенности прилагательных со значением цвета в русском языке и отражение этих особенностей в поэтических текстах XVIII–XX веков: дис. … канд. филол. наук. — СПб., 2000. — 222 с.

11. Кириллова М.Г. Подходы изучения цветообозначений в лингвистических исследованиях // Электронный сборник трудов молодых специалистов Полоцкого государственного университета. Образование, педагогика. — Новополоцк: ПГУ, 2018. — Вып. 23 (93). — С. 88–90.

12. Коптева Н.В. Функционирование колоризмов в художественном тексте как результат взаимодействия лингвокультурного и креативного факторов: автореф. — Ростов-на-Дону, 2005. — 28 с.

13. Косых Е.А. Система цветообозначений в русском языке // Вестник Барнаульского государственного педагогического университета. — 2002. — С. 28–34.

14. Кульпина В. Г. Лингвистика цвета: Термины цвета в польском и русском языках. — М.: Моск. Лицей, 2001. — 470 с.

15. Перова Е.Л. Концепция лингвистики цвета как самостоятельной научной парадигмы // Филология. — М., 2023. — № 2 (44). — С. 10–15.

16. Понятие и место колоративной лексики в современной лингвистике [Электронный ресурс]. — URL: https://helpiks.org/1-38421.html (дата обращения: 28.09.25).

17. Рахимова Г. Р. Колористическая лексика в аспекте языковой картины мира // Филологические науки. Вопросы теории и практики. — Тамбов, 2010. — С. 130–133.

18. Цигеман Э.С. Современные имплицитные значения цветонаименований, их связь с цветами и влияние на восприятие эмоционально-окрашенной лексики. — Томск: НИ ТГУ, 2017. — 47 с.

19. Berlin B., Kay P. Basic color terms: their universality and evolution. — Berkeley; Los Angeles: University of California Press, 1969. — 178 p.

20. Rosch E. Prototype Classification and Logical Classification: The Two Systems // New Trends in Conceptual Representation: Challenges to Piaget's Theory? / Ed. E. K. Scholnick. — Hillsdale, N.Y.: Lawrence Erlbaum Associates, 1983. — P. 73–86.

LINGUISTIC ANALYSIS OF LITERARY TEXTS USING ARTIFICIAL INTELLIGENCE ACROSS LANGUAGE SYSTEMS

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Abstract

The rapid development of artificial intelligence has significantly influenced contemporary linguistic research, particularly in the field of automated text analysis. While AI-based tools are increasingly applied to literary texts, their effectiveness across different language systems remains insufficiently explored. This article investigates the potential and limitations of artificial intelligence in conducting linguistic analysis of literary texts belonging to distinct language systems, including analytical, inflectional, and agglutinative languages. The study focuses on lexical, morphological, syntactic, and semantic levels of analysis, with special attention to culturally embedded meanings characteristic of literary discourse. By comparing AI-generated analyses across languages with differing grammatical structures, the research reveals systematic discrepancies in accuracy and interpretative depth. The findings demonstrate that although artificial intelligence can efficiently process surface-level linguistic features, its performance is uneven across language systems and remains limited in addressing morphological complexity and cultural semantics. The study argues that AI should be regarded as a supplementary analytical tool rather than a substitute for traditional philological analysis.

Keywords: artificial intelligence; linguistic analysis; literary texts; language systems; morphology; philology

1. Introduction

The integration of artificial intelligence into linguistic research has transformed the ways in which language data are processed, analyzed, and interpreted (Jurafsky & Martin, 2023; Goldberg, 2017). Advances in natural language processing and machine learning have enabled automated analysis of large textual corpora, offering new methodological possibilities for linguistics and philology (Manning & Schütze, 1999). Within this context, literary texts have increasingly become objects of AI-assisted analysis due to their linguistic richness and structural complexity (Underwood, 2019). However, the application of artificial intelligence to literary language raises important theoretical and methodological questions, particularly when texts originate from different language systems (Bender & Koller, 2020).

Literary texts represent a unique form of linguistic material. Unlike functional or technical texts, they are characterized by stylistic variation, figurative language, and culturally embedded meanings (Leech & Short, 2007; Stein, 1995). For philological research, literary texts provide valuable insight into lexical choice, syntactic organization, and semantic nuance (Widdowson, 2004). At the same time, these very features pose significant challenges for automated analysis. Artificial intelligence systems are typically trained on large datasets dominated by contemporary, standardized language use, which may limit their capacity to process non-standard structures and culturally specific expressions frequently found in literary discourse (Bender & Koller, 2020).

An additional challenge arises when artificial intelligence is applied across language systems with fundamentally different grammatical structures. Analytical languages such as English rely primarily on word order and auxiliary elements, whereas inflectional languages employ morphological variation to encode grammatical relationships (Crystal, 2003). Agglutinative languages, in turn, exhibit high levels of morphological complexity through the systematic use of affixes (Haspelmath & Sims, 2010). These typological differences influence how meaning is constructed and expressed, and consequently affect the performance of AI-driven linguistic analysis (Dixon, 2010). Despite the growing body of research on artificial intelligence in linguistics, comparative studies that address AI performance across diverse language systems remain limited (Tsarfaty et al., 2013).

The present study aims to examine how artificial intelligence conducts linguistic analysis of literary texts across different language systems and to identify the factors that contribute to variation in analytical outcomes. By focusing on lexical, morphological, syntactic, and semantic levels, this research seeks to determine which aspects of literary language are effectively captured by AI and which remain problematic (Jurafsky & Martin, 2023). Particular attention is given to the role of morphology and cultural context, as these elements often exceed the interpretative capacity of automated systems (Nida, 1993).

By adopting a comparative and critically grounded approach, this article contributes to ongoing discussions on the role of artificial intelligence in philological research. Rather than presenting AI as a comprehensive solution, the study positions it as a tool whose effectiveness is shaped by linguistic structure and cultural specificity (Zemanek, 1987). The findings underscore the continued importance of human linguistic expertise in the interpretation of literary texts and highlight the need for cautious and informed integration of artificial intelligence into philological methodology (Widdowson, 2004).

2. Theoretical Background

2.1 Linguistic Analysis of Literary Texts in Philology

Within philology, literary texts have traditionally been regarded as a primary source for the study of

language in its most elaborate and expressive form (Sapir, 1921; Bloomfield, 1933). Linguistic analysis of literary texts does not aim at aesthetic evaluation but rather at identifying how language functions on multiple levels within a culturally and historically situated context (Widdowson, 2004). From a philological perspective, literary texts provide insight into lexical choice, grammatical patterns, semantic layering, and pragmatic meaning (Leech & Short, 2007).

Unlike non-literary discourse, literary language frequently employs figurative expressions, syntactic variation, and intentional ambiguity (Stein, 1995). Philological analysis therefore relies on close reading and contextual interpretation, integrating linguistic structure with cultural, historical, and social knowledge (Nida, 1993). Such an approach enables the identification of how authors manipulate language to produce stylistic effects or reflect linguistic change (Crystal, 2003).

In contemporary philology, linguistic analysis increasingly incorporates computational methods alongside traditional qualitative approaches (Underwood, 2019). However, automated tools often struggle to account for metaphorical meaning and culturally encoded references, reinforcing the continued relevance of literary texts as a testing ground for both human and machine-based linguistic analysis (Bender & Koller, 2020).

2.2 Typology of Language Systems

Language typology plays a central role in understanding how meaning is structured and expressed across linguistic systems (Shopen, 2007). Languages are commonly classified according to their morphological and syntactic properties, including analytical, inflectional, and agglutinative types (Dixon, 2010).

Analytical languages rely primarily on word order and function words, while inflectional languages encode grammatical categories through internal word modification (Crystal, 2003). Agglutinative languages form words through systematic affixation, resulting in high morphological density (Haspelmath & Sims, 2010). These typological differences directly affect the performance of computational tools, particularly in literary contexts where stylistic variation and expressive flexibility are prominent (Tsarfaty et al., 2013).

2.3 Overview of AI Applications in Computational Linguistics

Artificial intelligence has become integral to computational linguistics, enabling automated tokenization, tagging, parsing, and semantic analysis (Manning & Schütze, 1999; Jurafsky & Martin, 2023). AI tools have also been applied to literary texts for authorship attribution, stylistic analysis, and thematic modeling (Underwood, 2019).

However, the effectiveness of these tools is constrained by their dependence on training data and probabilistic pattern recognition (Goldberg, 2017). Models trained on high-resource languages often struggle with morphologically rich or culturally marked texts (Tsarfaty et al., 2013), and they lack genuine semantic understanding (Bender & Koller, 2020). Consequently, AI-generated analyses must be critically evaluated within philological research (Zemanek, 1987).

3. Methodology

3.1 Criteria for Selecting Literary Texts

The selection of literary texts for the present study was guided by both linguistic and methodological considerations. First, the texts were chosen to represent comparable literary genres in order to minimize stylistic variation unrelated to language structure. Short prose excerpts were preferred, as they provide sufficient linguistic density while remaining manageable for detailed analysis. The selected texts originate from recognized literary traditions within each language and are representative of standard literary language rather than experimental or highly dialectal forms.

Second, the texts were selected to ensure functional equivalence across languages. Where possible, thematically similar excerpts were chosen to reduce the influence of content-based variation on linguistic analysis. The texts were written in the original languages and were not translations, as translated literary works may reflect the structural features of the target language rather than the source language. This criterion was essential for preserving the authenticity of each language system and for ensuring that observed analytical differences were attributable to linguistic structure rather than translation strategies.

Finally, the temporal scope of the texts was limited to modern literary works to avoid additional complexity arising from historical language change. This approach allowed the analysis to focus on contemporary language systems and on the performance of artificial intelligence when processing current literary language.

3.2 Description of Language Systems Analyzed

The study examines literary texts from three distinct language systems: analytical, inflectional, and agglutinative. Each system represents a different approach to encoding grammatical meaning and thus provides a basis for comparative analysis of AI performance.

Analytical languages are represented by English, which relies primarily on fixed word order and function words to express grammatical relationships. The relatively limited use of morphological marking makes English a suitable baseline for evaluating AI performance, as many computational models are optimized for analytical language structures.

Inflectional languages are represented by languages such as Russian or Estonian, where grammatical categories are expressed through internal changes to word forms. These languages exhibit greater morphological variation and syntactic flexibility, which increases the complexity of automated linguistic analysis. Literary texts in inflectional languages often employ rich inflectional patterns that contribute to stylistic nuance.

Agglutinative languages, represented by Kyrgyz or Turkish, encode grammatical information through the systematic addition of affixes to a root. This results in high morphological density and long word forms that

contain multiple layers of grammatical meaning. Such structural characteristics pose particular challenges for AI-based analysis, especially in tasks involving morphological segmentation and semantic interpretation.

3.3 AI Tools Used for Linguistic Analysis

The linguistic analysis in this study was conducted using a selection of established artificial intelligence–based tools commonly applied in computational linguistics research. The tools were chosen based on their accessibility, multilingual support, and capacity to perform core linguistic tasks such as tokenization, morphological tagging, syntactic parsing, and basic semantic analysis.

For general natural language processing tasks, the **spaCy** framework was employed. spaCy provides pretrained language models for multiple languages, including English and several inflectional languages, and supports part-of-speech tagging, dependency parsing, and named entity recognition. Its rule-based and statistical components allow for relatively transparent inspection of syntactic structures, making it suitable for comparative linguistic analysis.

To supplement syntactic and morphological analysis, **Stanford CoreNLP** was used, particularly for English-language texts. This toolkit offers robust syntactic parsing and lemmatization capabilities and has been widely validated in linguistic research. Its outputs were used as a reference point for evaluating AI performance in analytical language systems.

For multilingual and cross-linguistic analysis, models based on the **Hugging Face Transformers** library were applied. Specifically, transformer-based language models were used to generate token-level annotations and semantic representations across different language systems. These models enabled the examination of how contemporary AI architectures process linguistic structure beyond surface-level features.

In the case of agglutinative languages, where morphological complexity presents particular challenges, language-specific tools were employed when available. For Turkic languages, including Kyrgyz, **UDPipe** models trained on Universal Dependencies corpora were used to perform tokenization, lemmatization, and morphological tagging. These models provided insight into the extent to which AI tools can segment and interpret morphologically dense word forms.

For semantic analysis and contextual interpretation, large language models were used in an analytical capacity to generate descriptive summaries of lexical and semantic patterns. The outputs were treated as probabilistic linguistic interpretations rather than authoritative analyses and were evaluated critically against traditional philological interpretation.

All AI tools were applied without manual correction or post-editing in order to preserve methodological consistency. The resulting outputs were analyzed comparatively across language systems to identify patterns of accuracy, simplification, and error at lexical, morphological, syntactic, and semantic levels.

3.4 Parameters of Comparison

The comparison of AI-generated analyses was conducted across four primary linguistic parameters: lexical, morphological, syntactic, and semantic.

At the lexical level, the analysis focused on word frequency, lexical diversity, and the identification of key lexical items. The ability of AI tools to recognize stylistically significant vocabulary and to differentiate between content and function words was examined.

The morphological level involved the analysis of word formation, inflection, and affixation. This parameter was particularly significant for inflectional and agglutinative languages, where grammatical meaning is heavily encoded within word forms. Errors in morphological segmentation and tagging were systematically documented.

Syntactic analysis addressed sentence structure, word order, and the identification of grammatical relations. The study examined the extent to which AI tools accurately parsed complex literary sentences, including those with non-standard or stylistically marked structures.

At the semantic level, the analysis considered how AI tools processed meaning, including basic semantic roles and evaluative language. Particular attention was given to figurative expressions, metaphorical language, and culturally specific meanings, as these elements frequently challenge automated interpretation.

By applying these parameters consistently across language systems, the study aimed to provide a structured and comparative evaluation of artificial intelligence in linguistic analysis of literary texts.

4. Analysis and Results

The Kyrgyz extract was taken from the epic *Manas*, recorded from Sagymbay Orozbakov (Manas, 1958–1960), while the English extract was taken from William Shakespeare's *Sonnet 18* (Shakespeare, 1609/2024).

At the lexical level, AI tools showed strong performance in identifying salient content words across both texts (Jurafsky & Martin, 2023). However, derivational and thematic cohesion in the Kyrgyz extract was not consistently recognized, reflecting known limitations in processing morphologically rich languages (Haspelmath & Sims, 2010; Tsarfaty et al., 2013).

Semantic interpretation remained largely literal, particularly in the Kyrgyz epic passage, where culturally embedded meanings and symbolic transformation were not captured (Nida, 1993; Bender & Koller, 2020).

4.1 Comparative AI Analysis Across Language Systems

In order to evaluate the performance of artificial intelligence in linguistic analysis across different language systems, extended literary extracts from an agglutinative language (Kyrgyz) and an analytical language (English) were analyzed. The selected texts represent culturally significant literary traditions and exhibit linguistic features typical of their respective language systems.

The Kyrgyz extract was taken from the epic *Manas*, a monumental work of oral literature that reflects the grammatical, stylistic, and cultural characteristics of the Kyrgyz language. The English extract was taken from William Shakespeare's *Sonnet 18*, a canonical example of early modern English poetic language. Both texts are in the public domain and were analyzed in their original linguistic form.

4.2 Literary Extracts Used for Analysis

Kyrgyz extract (from the epic *Manas*):

Акыл толбой мас калып,
Каптап келген көп калмак.
Дүйнөсүн талап алылтыр,
Муну менен ал балдар.
Талаада боздоп калыптыр,
Балдар эрешен тартып, эр болуп.
Кечээ эр уулу менен тең болуп,
Эрбейип атка мингенде.
(Approximate gloss:
"Losing reason, as if drunk,
A multitude of Kalmak came flooding in.
They plundered the world,
And with this, the children [were left].
Left wailing in the open field,
The children were hardened, becoming men.
Only yesterday equal to a hero's son,
Today boldly mounting a horse.")

English extract (William Shakespeare, *Sonnet 18*):

Shall I compare thee to a summer's day?
Thou art more lovely and more temperate:
Rough winds do shake the darling buds of May,
And summer's lease hath all too short a date;
Sometime too hot the eye of heaven shines,
And often is his gold complexion dimm'd.

4.3 Lexical Analysis: Recognition and Frequency

At the lexical level, AI tools demonstrated relatively high accuracy in both language systems. In the English extract, the AI correctly identified lexical categories, distinguishing content words (*summer, winds, heaven, complexion*) from function words (*shall, I, thou, and*). Keyword extraction highlighted evaluative adjectives (*lovely, temperate*) and natural imagery, aligning with traditional linguistic interpretation.

In the Kyrgyz extract, AI tools successfully identified core lexical items such as *акыл* ("reason"), *калмак* ("Kalmak"), *балдар* ("children"), *талаа* ("field"), and *эр* ("hero/man"). These lexemes carry strong semantic and cultural significance within the epic tradition. Their correct identification indicates that AI performs adequately in recognizing high-frequency and semantically salient lexical units.

However, lexical cohesion was often weakened by AI reliance on surface forms. Derivationally and semantically related words (*эр, эрешен, эр уулу*) were treated as separate, unrelated items, resulting in fragmented lexical grouping and reduced recognition of thematic continuity.

4.4 Morphological Analysis: Agglutination as a Critical Challenge

The contrast between language systems was most evident at the morphological level. In the English extract, morphology posed minimal difficulty. Inflectional forms and possessive constructions were accurately lemmatized and interpreted, reflecting the relatively limited morphological marking of English.

In the Kyrgyz extract, morphological complexity significantly hindered AI analysis. Verb forms such as *калып*, *келген*, *талап алылтыр*, and *мингенде* encode tense, aspect, and voice through suffixation. AI tools frequently failed to segment these forms correctly, treating them as unanalyzed lexical units or mislabeling their grammatical functions.

As a result, temporal relations and aspectual distinctions crucial to the narrative progression—such as the contrast between past innocence and emerging heroism—were not fully captured. This confirms that agglutinative morphology remains a major challenge for automated linguistic analysis.

4.5 Syntactic Analysis: Fixed vs. Flexible Structures

Syntactic analysis of the English extract produced largely accurate results. AI tools correctly identified clause boundaries, subject–predicate relations, and comparative constructions. Dependency parsing reflected the relatively fixed word order of English, allowing for coherent syntactic representation even in poetic discourse.

In contrast, syntactic parsing of the Kyrgyz extract proved less reliable. Kyrgyz permits flexible word order, and syntactic roles are often signaled morphologically rather than positionally. AI-generated parses frequently imposed rigid subject–verb–object structures, which distorted the poetic parallelism and narrative flow of the epic passage.

Participial constructions and coordinated actions (*боздоп калыптыр*, *эрешен тартып, эр болуп*) were not consistently recognized as syntactically linked processes. This resulted in fragmented syntactic representations that failed to reflect the cumulative and transformative nature of the described events.

4.6 Semantic Interpretation: Literal Processing and Cultural Loss

At the semantic level, AI analysis revealed significant limitations in both language systems, though these were more pronounced in the Kyrgyz extract. In the English text, AI identified themes of comparison, temporality, and natural imagery, but reduced metaphorical and rhetorical functions to literal semantic relations.

In the Kyrgyz extract, semantic interpretation remained largely literal. While AI recognized actions such as invasion, plunder, and movement, it failed to capture the deeper cultural and symbolic meanings associated with forced maturation, collective trauma, and heroic emergence. Expressions describing children becoming warriors were processed as neutral developmental statements rather than as culturally charged representations of epic transformation.

4.7 Observed Patterns and Discrepancies

The revised analysis reveals several consistent patterns:

- AI demonstrates strong performance at the **lexical level**, particularly in identifying salient content words.
- **Agglutinative morphology** significantly reduces analytical accuracy and affects higher-level interpretation.
- **Syntactic flexibility and participial constructions** challenge AI models trained on fixed word-order languages.
- **Semantic depth and cultural symbolism** remain largely inaccessible to automated analysis.

Overall, the results confirm that artificial intelligence provides uneven linguistic analysis when applied to literary texts across different language systems. While AI tools offer valuable support for surface-level examination, their limitations become increasingly apparent in morphologically rich and culturally embedded epic discourse

5. Discussion

5.1 Uneven AI Performance Across Language Systems

The results of the analysis demonstrate that artificial intelligence performs unevenly when applied to linguistic analysis of literary texts across different language systems. This unevenness is not incidental but structurally обусловлено by the linguistic assumptions embedded in contemporary AI models. Most AI tools are developed and trained primarily on high-resource, analytical or mildly inflectional languages, which influences how grammatical relations, semantic patterns, and syntactic structures are identified and interpreted.

In analytical languages such as English, grammatical meaning is often expressed through fixed word order and auxiliary constructions. These features align well with AI parsing mechanisms, allowing for relatively accurate syntactic and lexical analysis. By contrast, in agglutinative languages such as Kyrgyz, grammatical information is densely encoded within word forms, requiring fine-grained morphological segmentation. AI systems frequently fail to isolate or correctly interpret these morphemes, leading to cascading errors in syntactic and semantic analysis.

The uneven performance observed in this study therefore reflects deeper typological mismatches between language systems and the computational architectures underlying AI-based linguistic tools.

5.2 Influence of Morphology and Cultural Context

Morphology emerged as one of the most influential factors affecting AI performance. In agglutinative languages, the accumulation of grammatical meaning within a single word poses significant challenges for automated analysis. When AI tools treat morphologically complex forms as indivisible units, essential grammatical information is lost, limiting interpretative accuracy at higher linguistic levels.

Cultural context further compounds these difficulties. Literary texts often rely on culturally embedded expressions, symbolic imagery, and traditional narrative structures that extend beyond literal meaning. While AI systems can process lexical and syntactic patterns, they lack access to shared cultural knowledge and historical context. As a result, metaphorical language and culturally significant motifs are frequently interpreted in a literal or simplified manner.

This limitation is particularly evident in epic and poetic traditions, where language functions not only as a means of communication but also as a carrier of collective memory and identity. AI-generated analysis, which operates on statistical associations rather than interpretative understanding, remains largely insensitive to these dimensions.

5.3 AI Output and Traditional Philological Analysis

A comparison between AI-generated output and traditional philological analysis reveals fundamental differences in analytical approach. Philological analysis is inherently interpretative, integrating linguistic structure with historical, cultural, and contextual knowledge. It allows for ambiguity, polysemy, and stylistic deviation, recognizing these features as meaningful rather than erroneous.

AI output, by contrast, prioritizes consistency, pattern recognition, and probabilistic prediction. While this approach is effective for large-scale data processing and surface-level analysis, it struggles to accommodate the intentional irregularities and expressive complexity of literary language. In the present study, AI tools frequently produced grammatically plausible yet interpretatively shallow analyses, particularly at the semantic level.

These findings suggest that artificial intelligence cannot replace traditional philological analysis but may serve as a complementary tool. When used critically and in conjunction with human expertise, AI can assist in identifying patterns and generating preliminary observations, which must then be evaluated and contextualized by the researcher.

6. Conclusion

6.1 Summary of Findings

This study examined the application of artificial intelligence to the linguistic analysis of literary texts across different language systems. The findings indicate that AI performs reliably at the lexical level and demonstrates reasonable accuracy in syntactic analysis of analytical languages. However, its effectiveness decreases significantly in the presence of morphological complexity, flexible syntax, and culturally embedded meaning.

Agglutinative language structures and literary discourse posed particular challenges, resulting in oversimplified or incomplete analyses. Semantic interpretation remained largely literal, with limited sensitivity to metaphor, symbolism, and cultural context.

6.2 Implications for Linguistics, Translation Studies, and Education

The results of this research have several implications for linguistic scholarship and applied fields. For linguistics, the findings highlight the importance of language typology in evaluating computational tools and caution against universal claims regarding AI effectiveness. In translation

studies, the limitations observed in semantic and cultural interpretation underscore the risks of relying on AI-generated analysis without human mediation, particularly for literary translation.

In educational contexts, AI may be effectively used as a supportive tool for demonstrating basic linguistic patterns or introducing computational methods. However, its limitations must be clearly communicated to students, especially in the study of literature and culturally complex texts. Philological training remains essential for developing critical interpretative skills that cannot be automated.

6.3 Directions for Future Research

Future research should expand the comparative scope of analysis to include additional language systems, particularly low-resource and historically attested languages. Further studies could also explore the integration of linguistically informed morphological models and culturally annotated datasets to improve AI performance. Finally, interdisciplinary collaboration between linguists, philologists, and computational researchers may contribute to more balanced and theoretically grounded applications of artificial intelligence in the study of literary language.

References

1. Bender, E. M., & Koller, A. (2020). Climbing towards NLU: On meaning, form, and understanding in the age of data. Proceedings of the 58th Annual Meeting of the Association for Computational Linguistics, 5185–5198.

2. Bloomfield, L. (1933). Language. Holt, Rinehart & Winston.

3. Crystal, D. (2003). The Cambridge encyclopedia of the English language. Cambridge University Press.

4. Dixon, R. M. W. (2010). Basic linguistic theory. Vol. 1: Methodology. Oxford University Press.

5. Fillmore, C. J. (1982). Frame semantics. In Linguistics in the morning calm (pp. 111–137). Hanshin Publishing Company.

6. Goldberg, Y. (2017). Neural network methods for natural language processing. Morgan & Claypool Publishers.

7. Haspelmath, M., & Sims, A. (2010). Understanding morphology. Routledge.

8. Jurafsky, D., & Martin, J. H. (2023). Speech and language processing (3rd ed.). Stanford University.

9. Leech, G., & Short, M. (2007). Style in fiction: A linguistic introduction to English fictional prose. Longman.

10. Manning, C. D., & Schütze, H. (1999). Foundations of statistical natural language processing. MIT Press.

11. Manas. (1958–1960). Manas: Kyrgyz epic poem (Recorded from Sagymbay Orozbakov). Kyrgyz State Publishing House. Retrieved from https://eposmanas.ru/manas_kg/-441/-442/

12. Nida, E. A. (1993). Language, culture, and translating. Shanghai Foreign Language Education Press.

13. Sapir, E. (1921). Language: An introduction to the study of speech. Harcourt, Brace & Company.

14. Shakespeare, W. (1609). Shakespeare's sonnets. Thomas Thorpe.

15. Shakespeare, W. (2024). Sonnet 18 ("Shall I compare thee to a summer's day?"). Poetry Foundation. https://www.poetryfoundation.org/poems/45087/sonnet-18-shall-i-compare-thee-to-a-summers-day

16. Shopen, T. (Ed.). (2007). Language typology and syntactic description. Cambridge University Press.

17. Stein, D. (1995). Stylistics. Cambridge University Press.

18. Tsarfaty, R., Seddah, D., Goldberg, Y., & Kübler, S. (2013). Parsing morphologically rich languages. Computational Linguistics, 39(1), 15–48.

19. Universal Dependencies Consortium. (2023). Universal dependencies documentation. Universal Dependencies Project. Retrieved from https://universaldependencies.org

20. Universal Dependencies Consortium. (2023). Universal dependencies for morphologically rich languages. Universal Dependencies Project. Retrieved from https://universaldependencies.org/morphology.html

21. Vaswani, A., Shazeer, N., Parmar, N., et al. (2017). Attention is all you need. Advances in Neural Information Processing Systems, 30, 5998–6008.

22. Widdowson, H. G. (2004). Text, context, pretext: Critical issues in discourse analysis. Blackwell Publishing.

23. Underwood, T. (2019). Machine learning and human perspective. PMLA, 134(1), 92–109.

24. Zemanek, H. (1987). Artificial intelligence and the limits of language understanding. AI & Society, 2(1), 15–27.

PHYSICAL SCIENCES

TIME TRAVELS ON EARTH IS AVAILABLE FOR USE[12]

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Abstract
The article explains that it will probably soon be possible to travel through time on Earth.. And such a possibility is created by the corrected version of the special theory of relativity (SRT). But the version of SRT studied in all physics textbooks states that time travel on Earth will never be available to people. Nevertheless, ignoring this opinion of the generally recognized service station, currently millions of air passengers already travel through time every day, which is confirmed by the translation of their watches to local time after landing the plane.

Keywords: special relativity theory, relativistic formulas, Multiverse, anti-universe, antimatter, anti-time, internal time, external time, time zones of Earth, time travels

1. Preface

The author published his three "top secret" articles in which the physical reality of imaginary numbers was proved, during the existence of the USSR. And after this, the Library of the US Congress contacted the author's place of work with a request to send an unclassified his publications. And at this time the author, having learned about the secret resolution[13] of the Presidium of the USSR Academy of Sciences1964 prohibiting any criticism of the works of Albert Einstein, not wanting to be repressed, stopped his research and left the Moscow region for Ukraine. And he resumed his research only after the collapse of the USSR, as a result of which Ukraine became independent. Later, already living in Ukraine, the author in 2008-2010. published five unclassified articles in English, in which he also proved the physical reality of imaginary numbers. And thus, with his publications, he made the unsuccessful ORERA experiment in 2011 unnecessary. However, participants in the ORERA experiment ignored these publications. And the incorrect version of the SRT still continues to be studied in all physics textbooks. And these textbooks are used in the educational process of universities, even the most prestigious ones.

2. Introduction

The article explains that the special theory of relativity (SRT), studied in all physics textbooks, rightly recognized as an outstanding scientific achievement due to the principle of relativism proposed in it, nevertheless, due to the lack of necessary experimental knowledge in the 20th century, turned out to be largely incorrect[14]. Therefore, she could not explain the phenomena of dark matter and dark energy, the problem of baryon asymmetry, denied the existence of tachyons and antimatter, and incorrectly solved other problems of astrophysics. And due to the inability to explain the relativistic formulas obtained by the creators of this theory in the hyperluminal speed range, the incorrect principle of not exceeding the speed of light was introduced into the SRT, from which incorrect conclusions were drawn about the existence in nature of our only visible universe and about the physical unreality of imaginary numbers. But by denying the physical reality of imaginary numbers, this incorrect SRT denied the existence of radio technology and computer technology, resonance and bell ringing, tsunamis, piano music, swaying children's swings and much more. Therefore, due to the complete lack of experimental proof of its truth of this version of SRT, Albert Einstein for its creation, even despite the fact that he was nominated for the Nobel Prize 66 times, never received it.

This incorrect version of the theory of relativity also denies the possibility of time travel for humans. But every day, millions of airplane passengers on Earth make such time travel that they don't need. And this article explains how to make time travel necessary and beneficial for people on Earth.

3. The version of SRT taught in all physics textbooks is incorrect

However, while being brilliant in its concept, the version of SRT taught in all physics textbooks is nevertheless largely incorrect, since:

- the relativistic formulas obtained in this SRT are incorrect, because it is ignored the fact that the argument 'velocity' in them, in accordance with Newton's first law, is the fourth spatial dimension[15] [1]-[5];
- the formula for the relativistic mass m(v) in the hyperluminal $v > c$ speed range corresponds to a physically unstable process that cannot exist in nature;
- being unable to explain the physical meaning of the imaginary values of the quantities *m(v), (v), l(v)*

[12] *This is reprint of the article "Antonov A. A. 2026. How to call yourself to yesterday? Norwegian Journal of Development of the International Science No 172".*
[13] *which has not yet been canceled*
[14] *For a new theory, this is forgivable. But then it still needs to be corrected.*
[15] *Not to be confused with the fourth dimension in four-dimensional space-time (Minkowski space).*

in the hyperluminal $v > c$ speed range, the authors of the SRT, in order not to explain their relativistic formulas in this range, introduced an incorrect postulate into it, called the principle of not exceeding the speed of light, which is incompatible with the fourth spatial dimension.

- in the 21st century, despite the fact that the attempt to refute SRT with the OPERA experiment [6] at the Large Hadron Collider was unsuccessful, it was still experimentally proven that imaginary numbers are physically real [7]-[24]. And, therefore, the principle of not exceeding the speed of light in the generally accepted SRT and this version of SRT itself, which is studied in textbooks, are incorrect [25]-[57].

In addition, the conclusions drawn from incorrect relativistic formulas using the incorrect principle of not exceeding the speed of light are also incorrect:

- about the existence in nature of our only visible universe;
- about the physical unreality of imaginary numbers.

4. Proof of the physical reality of imaginary numbers

But by now, numerous [7]-[24] experimental evidence of the physical reality of imaginary numbers have already been published. All of them are quite simple and can be completed by one radio engineer in less than one day. They can therefore always be repeated and checked in any other radio engineering laboratory. In contrast to these simple radio engineering experiments, the unsuccessful OPERA physics experiment at the Large Hadron Collider was carried out for a total of almost 15 years (2003-2018).

And so that the reader can convince himself of the truth of the mentioned radio enginee-ring experiments, let us consider one of them as an example. The rest are also quite simple expe-rimenta mentioned in the list of references.

From the well-known Ohm's law in the interpretation of Steinmetz [58], the validity of which is daily confirmed by millions of radio engineers throughout the world through their practical activities, it follows that in addition to the electrical resistance R of resistors, measured by real numbers, there are also electrical resistances $-j/\omega C$ of capacitors and $+j\omega L$ of inductors, which are measured by imaginary numbers.

Consequently, if these imaginary numbers $-j/\omega C$ and $+j\omega L$, in accordance with the generally accepted version of SRT are physically unreal, then the electrical resistance of any electrical *LCR*-circuit will always be measured in real numbers and will not depend on frequency. Therefore, when the frequency ω of the applied voltage changes, the amount of current flowing through such an electrical circuit will not change.

And vice versa, if the imaginary resistances $-j/\omega C$ and $+j\omega L$ are physically real, then the electrical resistance of any electrical *LCR*-circuit will be measured in complex numbers and when the frequency ω of the applied voltage changes, its resistance will change. Therefore, in accordance with Ohm's law, the magnitude of the current flowing through this electrical *LCR*- circuit will also change.

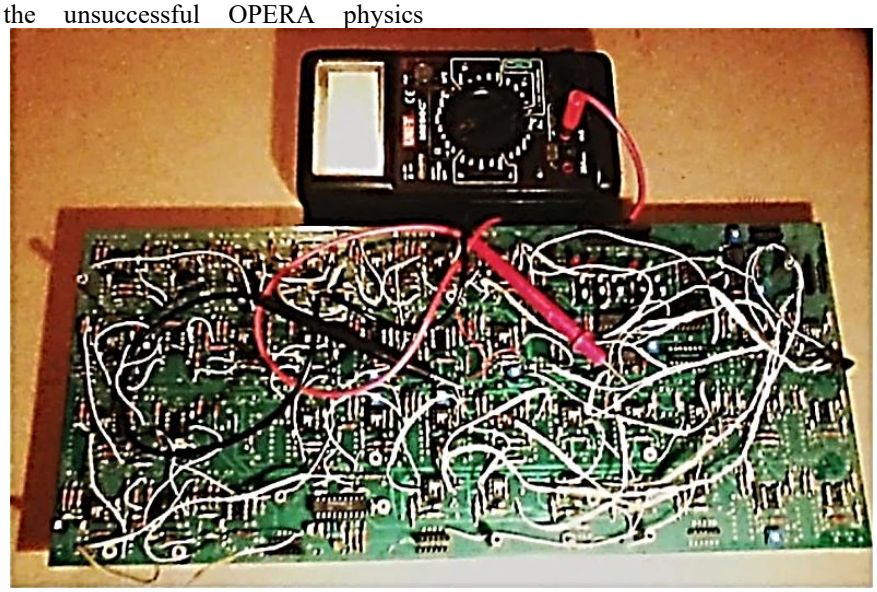

Fig 1. And this is quite sufficient instead of the Large Hadron Collider for successful experimental proof of the physical reality of imaginary numbers

Consequently, an experiment proving the physical reality of imaginary numbers is extremely simple. You just need to change the frequency ω of the voltage applied to any electrical *LCR*-circuit and measure the valueof electric current flowing through it. And all radio engineers know that in this case its value will change. Thus proving the physical reality of imaginary numbers.

Moreover, the physical reality of imaginary numbers can be experimentally proven even simpler (Fig. 1) - simply by measuring with a tester (otherwise called a multimeter) the value of the capacitance of any capacitor *C*. In fact, the tester first measures the value of the imaginary resistance $-j/\omega C$, which only then recalculates into the value of its capacitance. Those. in such an experiment, the imaginary quantity $-j/\omega C$ is actually measured, which proves its physical reality. Because you can only measure something that actually physically exists, even if you can't touch it. As well as

the value of the resistor *R*, which also cannot be touched.

However physicists did not do such an experiment, since in fact, as shown below, on the contrary, they need evidence of the physical unreality of imaginary numbers. Which do not exist in nature.

5. Corrected version of SRT

And since the physical reality of imaginary numbers has just been proven in the most indisputable way, it remains to fully and correctly explain (which no one has done over the past hundred years) the relativistic formulas of SRT [59]-[67].

$$m = \frac{m_0}{\sqrt{1-(v/c)^2}} \quad (1)$$

$$\Delta t = \Delta t_0 \sqrt{1-(v/c)^2} \quad (2)$$

$$l = l_0 \sqrt{1-(v/c)^2} \quad (3)$$

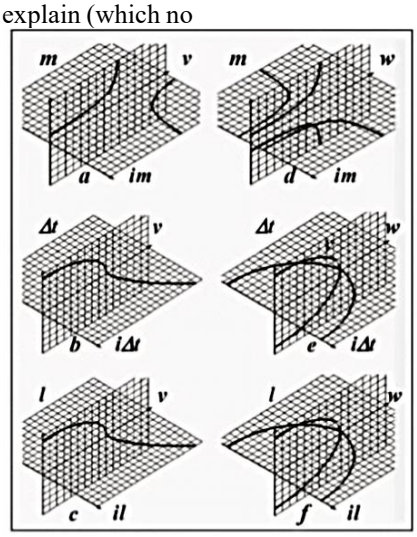

Fig 2. Graphs of functions m(v), Δt(v), l(v), corresponding to the existing and revised versions of SRT in the subluminal v < c and hyperluminal v > c ranges

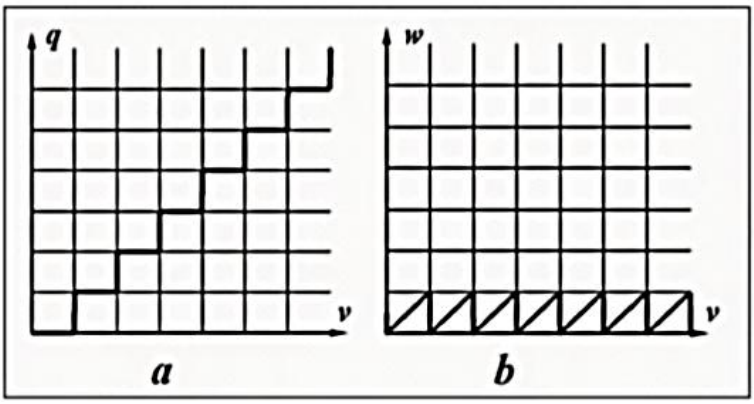

Fig. 3. Graphs of functions q(v) and w(v), illustrating the meaning of the "floor" function of discrete mathematics

in which m_0 is the rest mass of a moving body;
m is the relativistic mass of a moving body;
m is the relativistic mass of a moving body;
Δt_0 is the rest time of a moving body;
Δt is the relativistic time of a moving body;
l_0 is the rest length of a moving body;
l is the relativistic length of a moving body.

These formulas correspond to the graphs in Fig. 2a,b,c. And they show that these graphs in the subluminal $v < c$ and hyperluminal $v > c$ ranges of the argument v have different appearances. Therefore, the same processes cannot occur in these ranges. And in order for the same processes to occur in these ranges, the graphs of the corrected relativistic formulas should look the same, as shown in Fig. 2d,e,f. And for this, in formulas (1)-(3), since the speed v in them is the fourth spatial dimension, the factor i^q must be untroduced

$$m(q) = \frac{m_0 i^q}{\sqrt{1-(v/c-q)^2}} = \frac{m_0 i^q}{\sqrt{1-(w/c)^2}} \quad (4)$$

$$\Delta t(q) = \Delta t_0 i^q \sqrt{1-(v/c-q)^2} = \Delta t_0 i^q \sqrt{1-(w/c)^2} \quad (5)$$

$$l(q) = l_0 i^q \sqrt{1-(v/c-q)^2} = l_0 i^q \sqrt{1-(w/c)^2} \quad (6)$$

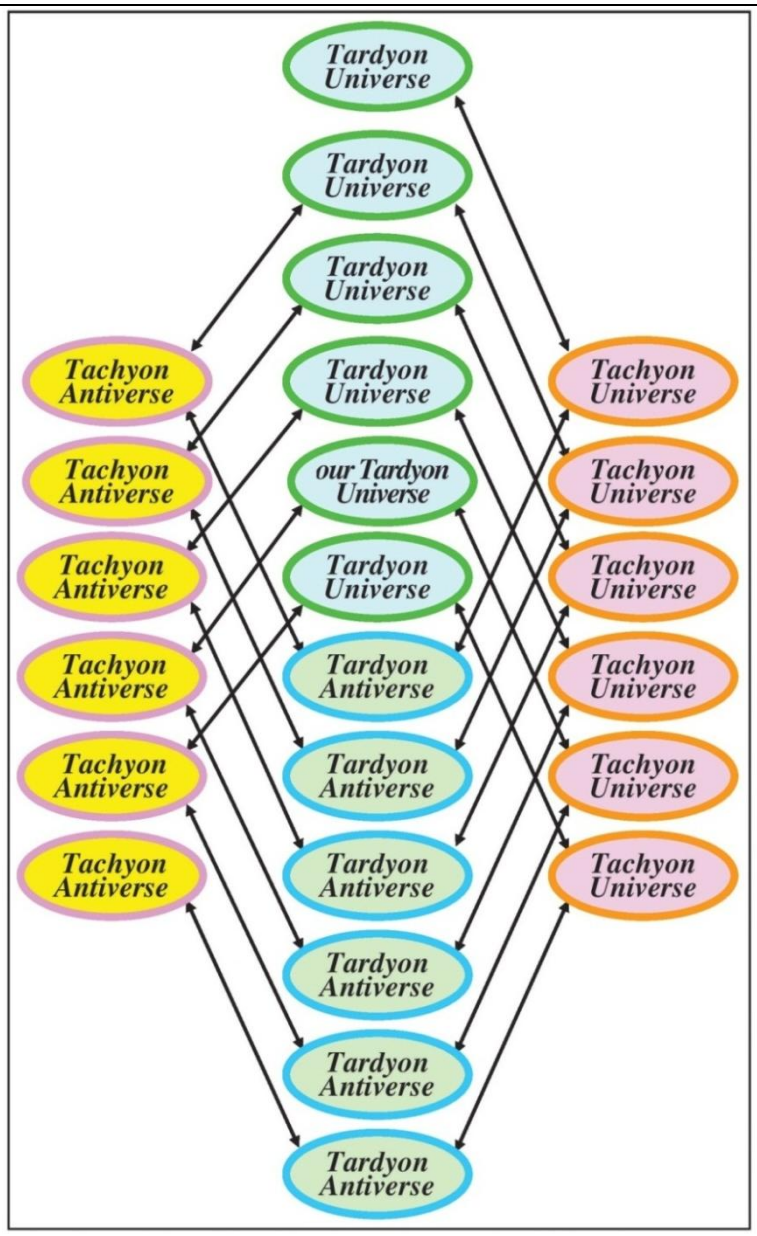

Fig. 4. Structure of the hidden Multiverse corresponding to the principle of physical reality of complex numbers

where $q(v) = \lfloor v_q/c \rfloor$ is the "floor" function of discrete mathematics from the argument v_q/c (its

graph shown in Fig. 3a), which is the fourth spatial dimension;

$w = v - qc$ is the local speed in all universes (its graph is shown in Fig. 3b).

At that, this function iq in formulas (4)-(6), which determines the essence of each universe, for integer values of the argument *q(v)* equal to ... *0,1,2,3,4,5,...*, takes the values *+1, +i, -1, -i, +1, +i, ...* etc. And the value $q(v) = 0$[16] in formulas (4)-(6) for the range of sublight *speeds* $v < c$ corresponds (since $i^0 = 1$) to our visible universe, which for definiteness we will call the tardyon universe[17] (see Fig. 4). The value $q(v) = 1$ in the hyperluminal speed range $2c > v > c$ corresponds (since $i^1 = i$) to some other invisible universe, since it is located beyond the event horizon. For definiteness, we will therefore call it the tachyon universe[18]. Then the value $q(v) = 2$ in the speed range $3c > v > 2c$ will correspond (since $i^2 = -1$) to an invisible tardion antiverse. The value $q(v) = 3$, in the speed range $4c > v > 3c$ will correspond (since $i^3 = -i$) to an invisible tachyon antiuniverse. The value $q(v) = 4$ in the speed range $5c > v > 4c$ will correspond (since $i^4 = +1$) to another (and therefore also invisible) tardyon universe. The value $q(v) = 5$ in the speed range $6c > v > 5c$ will correspond (since $i^5 = +i$)) to another tachyon universe. Etc.

Consequently, in nature there is not only, as stated in the generally accepted version of SRT, our visible universe corresponding to formulas (1)-(3), but also many other mutually invisible[19] universes and antiuniverses corresponding to formulas (4)-(6). And these mutually invisible universes and antiuniverses,

[16] *Those if we take our visible universe as the origin of coordinates q.*

[17] *Tardyon universe is a term used by Isaak Asimov in his short story 'Take a Match'.*

[18] *Tachyon universe is a term used by Isaak Asimov in his short story 'Take a Match'.*

[19] *Since they are all beyond the event horizon*

together with our visible universe, form the Multiverse, which we therefore called hidden. Such a hidden Multiverse, the structure of which is helical, is shown in Fig. 4.

6. The invisible universes and anti-universes of the hidden Multiverse are dark matter and dark energy

However, in this structure it is still necessary to take into account and explain the phenomena of dark matter and dark energy, so named because of their incomprehensibility, since not a single chemical element has been found in them, and also because they do not emit, absorb, reflect or refract electromagnetic radiation and, therefore, are invisible. Finally, it is not clear why dark matter and dark energy, which accounts for more than 95% of all mass-energy contained in nature, are being persistently searched for at the Large Hadron Collider in the microcosm of our only visible universe. In fact, it is impossible to explain it this way.

Therefore, let us assume that dark matter and dark energy are all other mutually invisible universes and antiuniverses of the hidden Multiverse. Then the phenomena of dark matter and dark energy will be a gravitational shadow on our visible universe from the remaining mutually invisible universes and antiuniverses included in the hidden Multiverse. That is why these phenomena do not contain, like our shadow on a sunny day, a single chemical element, and dark matter and dark energy contain more than 95% of all mass-energy contained in the hidden Multiverse. This assumption explains all the incomprehensibility of phenomena simply and clearly. That's why we will use it.

Then, assuming that over the billions of years of its existence, the mass-energy of all universes and antiuniverses of the hidden Multiverse, due to the presence of a huge number of portals between them according to the law of communicating vessels, has been largely averaged, it becomes possible, using the data obtained by the WMAP and Planck spacecraft, to determine the structure of the hidden Multiverse. And according to data obtained by the WMAP spacecraft [68], the mass-energy of our visible universe (in fact, our hidden Multiverse) consists of 4.6% baryonic matter, 22.4% dark matter and 73.0% dark energy. And according to more recent data obtained by the Planck spacecraft [69], the mass-energy of our visible universe (again, actually our hidden Multiverse) consists of 4.9% baryonic matter, 26.8% dark matter and 68.3% dark energy. As you can see, these data differ little from each other, which proves their truth. Therefore:

- the entire hidden Multiverse, according to experimental data obtained by the WMAP spacecraft, consists of 100% / 4.6% = 21.8 parallel universes, and according to data obtai- ned by the Planck spacecraft, it consists of 100% / 4.9% = 20.4 parallel universes;
- dark matter, according to experimental data obtained by the WMAP spacecraft, consists of 22.4% / 4.6% = 4.9 parallel universes, and according to data obtained by the Planck spacecraft, it consists of 26.8% / 4.9% = 5.5 parallel universes;
- dark energy, according to experimental data obtained by the WMAP spacecraft, consists of 73.0% / 4.6% = 15.9 parallel universes, and according to data obtained by the Planck spacecraft, it consists of 8.3% / 4.9% = 13.9 parallel universes;
- and our visible universe, naturally, is only one.

7. Corrected version of SRT (continued)

As can be seen, received by the WMAP and Planck spacecraft experimental data did not confirm the above conclusions about the structure of the hidden Multiverse, since our visible universe actually has not two neighboring invisible parallel universes - one tachyon universe and one tachyon antiuniverse - but five or six[20].

Consequently, there was some error in the previous reasoning. And we, it turns out, were wrong in assuming that in the hidden Multiverse there is only one additional dimension q. And therefore, when describing it, they used complex numbers containing only one imaginary unit. And now, in order for six other parallel universes to coexist with our visible universe in the really existing hidden Multiverse - three tachyon universes and three tachyon antiuniverses - it is necessary to have three additional dimensions *q, r, s.* At the same time relativistic formulas must be corrected again as follows [70]-[77]

$$m(q,r,s)=\frac{m_0 i_1^q i_2^r i_3^s}{\sqrt{1-[v/c-(q+r+s)]^2}} \quad (7)$$

$$\Delta t(q,r,s)=\Delta t_0 i_1^q i_2^r i_3^s \sqrt{1-[v/c-(q+r+s)]^2} \quad (8)$$

$$l(q,r,s)=l_0 i_1^q i_2^r i_3^s \sqrt{1-[v/c-(q+r+s)]^2} \quad (9)$$

where $q(v)=\lfloor v_q/c \rfloor$ is the "floor" function of discrete mathematics from the argument v_q/c

which is one of the orthogonal coordinates q of the fourth spatial dimension v;

$r(v)=\lfloor v_r/c \rfloor$ is the "floor" function of discrete mathematics from the argument v_r/c which is another orthogonal coordinate r of the fourth spatial dimension v;

$s(v)=\lfloor v_s/c \rfloor$ is the "floor" function of discrete mathematics from the argument v_s/c which is another orthogonal coordinate s of the fourth spatial dimension v;

v_q, v_r, v_s is projections of the velocity vector v onto the orthogonal coordinates *q, r, s* (see Fig. 4).

The space of such a hidden Multiverse will already be six-dimensional (see Fig. 5). And its structure will correspond to the quaternions $\sigma + i_1\omega_1 + i_2\omega_2 + i_3\omega_3$, i.e. hypercomplex numbers [78] containing exactly three imaginary units i_1, i_2, i_3, which are related to each other by the relations

$$i_1^2=i_2^2=i_3^2=-1 \quad (10)$$

[20] *According to WMAP data 4.9 universes and according to Planck data 5.5 universes*

$$i_1 i_2 i_3 = i_2 i_3 i_1 = i_3 i_1 i_2 = -1 \quad (11)$$

$$i_1 i_3 i_2 = i_2 i_1 i_3 = i_3 i_2 i_1 = 1 \quad (12)$$

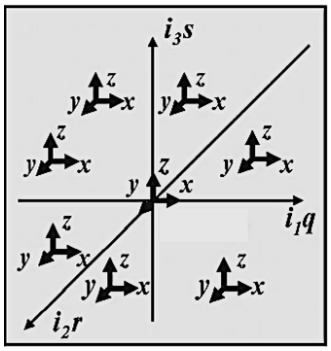

Fig. 5. Six-dimensional space of the hidden Multiverse, where q, r, s are the coordinates of invisible parallel universes, and x, y, z are the coordinates of the matter content in each parallel universe

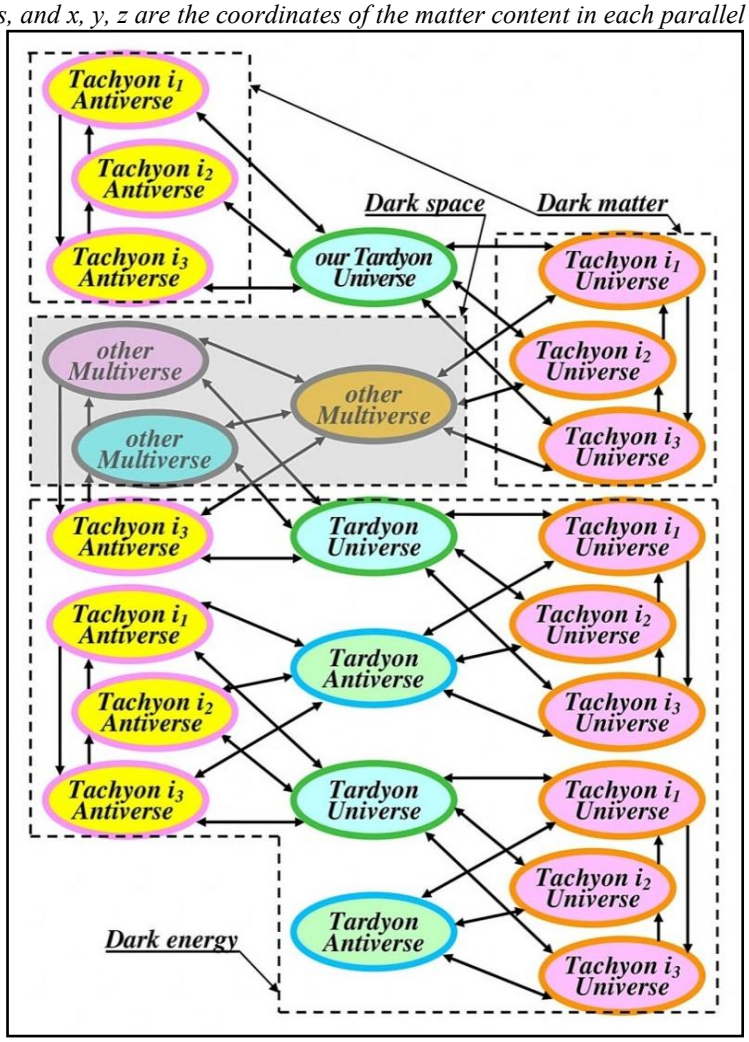

Fig. 6. Structure of the hidden Multiverse corresponding to the principle of physical reality of hyper-complex numbers

In such a quaternion structure of the hidden Multiverse [79], in contrast to its structure considered earlier (in Fig. 4), the distribution of material content in each three-dimensional parallel

universe will be determined by a certain function $f_{q,r,s}(x,y,z)$, and the coordinates of these universes will be determined by the values i_1q, i_2r, i_3s. Those the hidden Multiverse (see Fig. 6) will be described by the formula $f_{q,r,s}(x,y,z) + i_1q + i_2r + i_3s$. This is exactly what Lisa Randall predicted: *"Perhaps we live in a three-dimensional pocket of higher dimensional space"*.

From formulas (7)-(9) it follows that such a hidden Multiverse still has a helical structure, and its mutually invisible universes and antiuniverses (in addition to our visible universe) form dark matter and dark energy. In this case, it is possible to move into the tardion antiuniverse from the tardion universe and into the tardion universe from the tardion antiuniverse in various, but not arbitrary, ways, but only in such a way (see Fig. 6), in which the value of i^q will successive-ly take on the values $+1$, $+ i_1 \oplus i_2 \oplus i_3$, -1, $- i_1 \oplus i_2 \oplus i_3$, $+1$, … and etc., where $\oplus$ is the symbol of the logical operation of discrete mathematics 'exclusive OR'. In this case, different trajectories of movement from one

universe (or antiuniverse) to another can differ only due to the replacement of some tachyon universes from i_1, i_2, i_3 with others and some tachyon anti-universes from i_1, i_2, i_3 with others. Consequently, tachyon universes i_1, i_2, i_3 in the hidden Multiverse are located parallel to each other. Tachyon antiuniverses i_1, i_2, i_3 are also located parallel to each other for the same reasons. And therefore, in the hidden Multiverse, when transitioning from any tardion universe to a tardion anti-universe and then to another tardion universe, parallel universes and antiverses must alternate in the following sequence - 'tardion universe', 'one of the tachyon universes', 'tardion anti-universe', 'one of the tachyon anti-universes', 'tardion universe', 'one of tachyon universes', etc.

One of the easiest to explain such possible quaternion structures of the hidden Multiverse is shown in Fig. 6. Its difference from the structure shown in Fig. 3 is the presence in it of several different tachyon universes and antiuniverses located in parallel, corresponding to three imagiз-nary units i_1, i_2, i_3 Another difference is the presence in such a structure of the Multiverse of not only bidirectional portals corresponding to formula (7) and indicated by two-way arrows, but also unidirectional portals corresponding to formulas (8), (9) and indicated by one-way arrows.

In Fig. 6 all these transitions are shown. Moreover, since the data obtained by the WMAP and Planck spacecraft correspond to the not closed screw structures of our hidden Multiverse, united through the corresponding portals with other Multiverses, then all together they form the Hyperuniverse.

8. How to see invisible universes and anti-universes?

But in order to believe in the existence of the Multiverse mentioned in the article instead of the Monoverse mentioned in the textbooks, experimental confirmation of the above is necessary [80]-[97]. Those. it is necessary to prove that in addition to our visible universe, there are other universes and antiuniverses in nature.

And it is possible to do this. After all, invisible universes and anti-universes in outer space, continuously drifting, touch each other in many places and even submerge slightly into each other, forming transitions called portals between the touching universes and anti-universes. And since the constellations in the starry sky in neighboring universes and antiuniverses are always different[21], when moving through portals, the map of the starry sky in them will change, which will prove the existence of invisible universes neighboring the Earth. On Earth there are more than two hundred thousand anomalous zones[22] [98]-[101], which are entrances to portals. Moreover, in some of them observatories are already located. For example, the Main Astronomical Observatory of the Academy of Sciences of Ukraine is 12 km away from the center of the capital of Ukraine, Kyiv, in the Goloseevsky forest. Therefore, by comparing maps of the starry sky on a computer in portals (or even in anomalous zones) and outside portals, universes neighboring the Earth can be discovered. And as a result of astro-geophysical studies of portals, it will be possible to determine the main parameters of neighboring tachyon universes and antiuniverses. Which will ultimately allow us to determine the structure of our hidden Multiverse.

9. Where are antimatter and anti-time located?

And this structure of the hidden Multiverse allows us to explain another problem that is currently inexplicable within the framework of all physics textbooks - where antimatter is located [102]-[112]. It is clear that it cannot be in our visible universe[23], since due to its annihilation with matter, our universe would then cease to exist. But the fact that antimatter exists has been proven experimentally. In 1995, a sensational result was obtained at CERN - scientists managed to obtain nine antihydrogen atoms, which lasted for about forty billionths of a second. And just one gram of such antihydrogen would cost 662.5 trillion dollars.

Consequently, this experiment can be considered proof that, in accordance with formulas (7)-(9), antimatter can exist in nature in the invisible tardyon and tachyon antiuniverses of the hidden Multiverse and Hyperuniverse. (see Fig. 6). Moreover, in these invisible tardyon and tachyon anti-universes, anti-time and anti-space also exist.

10. Time travels

And the discovery of anti-time already allows us to assert that due to the choice of one or another route of travel in space, time travel also becomes possible [113]-[123], since from formulas (8), (9) it follows that time Δt in universes and antiuniverses during such travel will always change simultaneously with the change in distance l. But since neither the portals, much less the universes and anti-universes of the hidden Multiverse, are still unexplored, time travel in space is now inaccessible to us. And that's why we're interested in time travel on Earth now.

However, although official modern science admits the possibility of time travel in some exotic situations in the special[24] and general[25] theories of relativity, as well as in quantum physics[26] , it still claims that time travel of people on Earth, neither now nor in the distant future, will never be possible.

Nevertheless, these time travels on Earth are now already carried out by airplane flights. And millions of people take part in these flights every day, since upon landing at any airport, air passengers always change

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[21] Like all people, everything that is in their apartments

[22] Which in itself confidently – more than two hundred thousand times – also confirms the existence of neighboring universes and anti-universes.

[23] But the textbooks state that there are no other universes in nature besides it. And this, natura-lly, gives reason to doubt the truth of this version of SRT.

[24] For example, in the 'twin paradox'

[25] For example, in a region of ultra-high gravity near the event horizon of a black hole

[26] For example, as a result of teleportation not of information, but of physical objects

their watches to a local time other than at the airport of departure. Thus, they confirm their time travel. Indeed, due to the rotation of the Earth and the presence of time zones on it, movement in space on Earth, as in space, is always accompanied by movement in time.

And when explaining this situation, we must take into account the existence in nature of two different types of time that we will use - internal human time, which we have always used until now, and external time, which, on the contrary, we have never used before. These two times are generated by different processes that exist independently of each other and have different features. Internal time is determined by processes occurring in human bodies. One second is one contraction of the human heart. Therefore, internal time is the biological time of people. External time is determined by processes occurring in the external environment. Namely, by the rotation of the Earth and the existence of time zones. These features of it are reflected in formula, absent from physics textbooks, derived from the relativistic SRT formulas (5), (6) and (8), (9)

$\Delta t = \Delta t_0 \, l / l_0$ (13)

in which Δt is external time in hours;

Δt_0 – 24 hours;

l – path length in the direction perpendicular to time zones;

l_0 – the length of a circle that intersects 24 time zones at a given latitude.

These two different times also have different properties. Human biological time cannot flow backwards. A person cannot return to his youth or childhood. And external time, when changing the direction of movement, can change its sign - the plane can fly across time zones both to the west and to the east. When the speed of movement of the aircraft changes, the value of external time will also change. Therefore, in the external environment it is possible to move both into the past and into the future. Moreover, even short-term movements in external time can sometimes be very useful[27]. This is known to everyone, although it has not yet been used in any way in human activity. But this is a free resource given to us by nature for solving the problem of people traveling through time, which would even seem easy to use (you just need to fly on an airplane).

The only difficulty with this is that such time travel on Earth necessarily involves traveling long distances, which is why they are not used. However, this problem can be overcome. Aircrafts flights must be carried out in compliance with two mandatory conditions:

- the flight of the aircraft must be around the world, i.e. all the time from take-off to landing at the same airfieldfrom which the plane took off, it must be carried out in the same direction - to the West or to the East, as a result of which, ultimately, the movement of the aircraft in space can be ignored;

Table 1.

Examples of business jet performance flight performance characteristics that could be used for time travels

Aircrafts	**Maximum range**	**Cruising speed**	**Hourly rates**	**Seats**
Citation Latitude	5 300 km	815 km/h	3 500 €/hour	8
Citation Longitude	7 400 km	910 km/h	5 000 €/hour	12
Challenger 300	5 700 km	850 km/h	4 900 €/hour	8
Challenger 350	5 926 km	850 km/h	4 000 €/hour	9
Challenger 600	5 500 km	850 km/h	4 600 €/hour	12
Challenger 3500	6 297 km	985 km/h	5 500 €/hour	10
Falcon 20	4 200 km	987 km/h	3 900 €/hour	8
Falcon 50/50EX	5 600 km	850 km/h	4 900 €/hour	8-10
Global 5500	10 927 km	900 km/h	8 000 €/hour	16
Gulfstream G150	5 200 km	850 km/h	3 900 €/hour	6-8
Gulfstream G200	5 000 km	870 km/h	6 200 €/hour	8
Hawker 850 XP	4 800 km	750 km/h	3 400 €/hour	6-8
Hawker 900XP	5 400 km	865 km/h	3 700 €/hour	6-8
Hawker 4000	5 280 km	890 km/h	5 400 €/hour	10
Learjet 70	3 815 km	967 km/h	3 500 €/hour	7
Legacy 450	5 370 km	860 km/h	3 300 €/hour	8
Praetor 600	7 400 km	850 km/h	6 000 €/hour	12

[27] *For example, by traveling time first to the past and then to the future, it would probably be possible to save President John Fitzgerald Kennedy after the assassination attempt* [124]-[134].

Table 2.

The value of external time at different latitudes

Location of departure and arrival airfields	Geographic coordinates of the airfield	Size of 24 time zones for a round-the-world flight	Size of one time zone.
Santiago de Chile	33,45° S.	33422 km	1393 km
Buenos Aires	34,60° S.	33021 km	1375 km
Melbourne	37,82° S.	31339 km	1306 km
New York City	40,72º N.	30456 km	1269 км
Reykjavík	64,15° N.	17616 km	734 km
Murmansk	69,58° N.	14424 km	601 km
Kirkenes	69,73° N.	14376 km	599 km
Longyearbyen (Spits-bergen, Norway)	78,13° N.	8184 km	341 km
Alert, (Canada)	82,5° N.	5230 km	218 km

• the aircraft must fly at a high enough speed that it will cross each time zone in less than one hour of domestic time

Moreover, there are a great many aircraft models suitable for time travel. They are called business jets[28]. Table 1 illustrates the performance characteristics of some of these business jets. Table 2 lists airfields close enough to the North Pole to provide the shortest possible round-the-world flight route.

Therefore, time travels to the present is already physically and technically feasible.

12.Conclusion

From the above it follows that for Albert Einstein in his version of SRT, it turns out that the most important thing was to prove not physical reality, but, on the contrary, the physical unreality of imaginary numbers. Because otherwise it became clear to everyone that his theory was frankly incorrect.

But the physical reality of imaginary numbers in radio engineering was factually proven by Charles Proteus Steinmetz in his proposed interpretation of Ohm's law back in 1893. That is. before the creation by Albert Einstein and Jules Henri Poincaré in 1905 of the version of SRT that is now studied in all physics textbooks. And since then, radio engineers have never had the slightest reason to doubt this, since always when the frequency of the sinusoidal voltage applied to any electrical *LCR*-circuit changes, the amount of current flowing through it changes. This well-known fact, which occurs in the practical activities of radio engineers literally at every step, is an extremely simple, absolutely understandable and irrefutable proof of the physical reality of imaginary numbers.

However, Albert Einstein, in the now generally accepted version of SRT, needed to somehow obligatorily object to this[29]. For this reason, a postulate[30] was introduced into the SRT, called the principle of not exceeding the speed of light, from which a conclusion was made about the physical unreality of imaginary numbers [31], which was not confirmed by any experiments. And only the Nobel Committee - and this causes the greatest respect for it - remained faithful to common sense and scientific integrity. Due to the lack of any experimental evidence of the truth of the proposed version of SRT, despite the fact that Albert Einstein was nominated for the Nobel Prize 66 times, he never received it for this theory.

And in order to preserve the denial of the physical reality of imaginary numbers in SRT, relativistic physicists had to make great sacrifices. In particular, in order to create the impression that it is impossible to refute the statement of SRT about the physical unreality of imaginary numbers, at the Large Hadron Collider (worth ten billion dollars), the OPERA collaboration, which includes more than one hundred of the most authoritative physics professors, carried out the unsuccessful OPERA experiment for almost 15 years[32] (2003-2018), which allegedly had as its goal proving the physical reality of imaginary numbers, but not managed to do it. And thereby allegedly proving the impossibility of refuting the statement about the physical unreality of imaginary numbers. In 2011, its sensationally successful completion was even announced, but six months later in 2012 it was announced that it had been refuted at the same Large Hadron Collider by the ICARUS experiment.

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[28] A business jet is a small private jet aircraft for transporting a limited number of passengers (usually from 6 to 20) on an individual order for businessmen, officials and VIPs; it features a higher level of comfort, the ability to take off from small airfields and high speed, allowing it to cross time zones in less than one hour of internal passenger and crew time.

[29] Unable to explain in any other way the incorrect relativistic formulas of SRT in the hyperlight range of speeds

[30] As it turned out later, it turned out to be incorrect and refuted by all published experimental evidence of the physical reality of imaginary numbers.

[31] At the beginning of the 20th century, this assumption saved special relativity, as it allowed it to be explained somehow. Otherwise, a theory that its creators couldn't explain would have been of no use to anyone. Therefore, back then, such an assumption, as a temporary measure, was acceptable. But now, in the process of knowledge, it's time to move on.

[32] Let's remember - one day is more than enough for a radio engineering experiment proving the physical reality of imaginary numbers.

For this reason, numerous publications were ignored, citing simple and easily understood radio engineering experiments that successfully demonstrated the physical reality of imaginary numbers and explained that if imaginary numbers were truly, as claimed in the SRT, physically unreal, then all radio engineering devices and computers would not exist, tsunamis, bell ringing, piano music would not exist, children's swings would not swing after a parent's push, and much more.

Furthermore, because of the assertion of the physical unreality of imaginary numbers and, therefore, the existence of our only visible universe in nature, it turned out that antimatter and tachyons had no place in single visible universe. The corrected version of the SRT, however, explains where they are located.

It also turned out that due to the statement about the physical unreality of imaginary numbers and therefore about the existence in nature of our only visible universe, the phenomena of dark matter and dark energy have not been and will never be explained, since dark matter and dark energy are actually, according to the corrected version of SRT, mutually invisible universes and antiuniverses of the really existing hidden Multiverse.

More than two hundred thousand anomalous zones have also been discovered on Earth, which are entrances to portals to the invisible universes and antiuniverses neighboring our visible universe. And even this alone already proves their existence. Moreover, these universes and antiuniverses, invisible outside the portals, can also be seen by astronomical observations of the starry sky in portals. But these low-cost astronomical observations, which would allow sensational scientific discoveries of other universes, are still not carried out due to fears that these invisible neighboring universes and antiuniverses can actually be seen. And then the version of SRT studied in textbooks will undoubtedly have to be recognized as incorrect.

In the version of SRT studied in physics textbooks, it was also concluded that time travel is impossible for people. Although in fact, millions of air passengers on Earth already make such time travel every day, which is confirmed by the translation of their watches to local time after the planes land. But since such time travel by airline passengers occurs simultaneously with travel on Earth, they are not used. And the article explains how it is still physically and technically possible to travel through time on airplanes without ultimately traveling through space.

Less expensive telephone time travel is also possible, which, when needed, can be implemented quickly and inexpensively. Then telephone conversations with people located in the past or future tense will become publicly available. However, probably the most promising is the joint use of aviation and telephone options for time travel: aviation when crossing time zones over the ocean, and telephone when crossing them over land.

References

1. Antonov A.A. (2022). Dark Matter and Dark Energy, Which are Inexplicable in the Microcosm, are Mutually Invisible Universes and Anti-universes of the Hidden Multiverse. European Journal of Applied Sciences, Services for Science and Education. UK. 13(06). 84-107. DOI:10.14738/aivp.1306.19658.

2. Antonov A. A. 2025. Dark matter and dark energy are mutually invisible universes and anti-universes of the hidden Multiverse. German International Journal of Modern Science. 113. 27- 42. DOI: 10.5281/zenodo.17286973

3. Antonov A. A. 2025. Dark matter and dark energy are invisible universes and anti-universes of the hidden Multiverse. Journal of science. Lyon. 71. 38-52. https://doi.org/10.5281/zenodo.17533496

4. Antonov A. A. 2025. Dark matter and dark energy are mutually invisible universes and anti-universes of the hidden Multiverse. Annali d'Italia. 72. 28-42. DOI: 10.5281/zenodo.17463768

5. Antonov A. A. 2025. Dark matter and dark energy, which are inexplicable in the microcosm, are universes and anti-universes of the hidden Multiverse. XVIII International Scientific and Practical Conference "Theoretical and practical perspectives of modern science". 28-29.10.2025, Stockholm. Sweden. 69-86. DOI https://doi.org/10.5281/zenodo.17513357

6. Adam T., Agafonova N., Aleksandrov A. et al. (2012). Measurement of the neutrino velocity with the OPERA detector in the CNGS beam. arxiv:1109.4897v4 [hep-ex].

7. Antonov A. A. (2008). Physical Reality of Resonance on Complex Frequencies. European Journal of Scientific Research. 21(4). 627-641.

8. Antonov A. A. (2009). Resonance on Real and Complex Frequencies. European Journal of Scientific Research. 28(2). 193-204.

9. Antonov A. A. (2010). New Interpretation of Resonance. International Journal of Pure and Applied Sciences and Technology. 1(2). 1-12. http://doi.org/10.17686/sced_rusnauka_2010-888

10. Antonov A. A. (2010). Oscillation processes as a tool of physics cognition. American Journal of Scientific and Industrial Research. 1(2). 342-349. doi:10.5251/ajsir.2010.1.2.342.349

11. Antonov A. A. (2010). Solution of algebraic quadratic equations taking into account transitional processes in oscillation systems. General Mathematics Notes. 1(9). 11-16.

http://doi.org/10.17686/sced_rusnauka_2010-887

12. Antonov A. A. (2013). Physical Reality of Complex Numbers. International Journal of Management, IT and Engineering. 3(4). 219-230. http://doi.org/10.17686/sced_rusnauka_2013-898

13. Antonov A. A. (2015). Physical reality of complex numbers is proved by research of resonance. General Mathematics Notes. 31(2). 34-53.

http://www.emis.de/journals/GMN/yahoo_site_admin/assets/docs/4_GMN-9212-V31N2. 1293701.pdf

14. Antonov A.A. (2015). Principle of physical reality of imaginary and complex numbers in the modern cosmology: the nature of dark matter and dark energy. Journal of the Russian physico-chemical Society. 87(1). 328-355. http://doi.org/10.17686/sced_rusnauka_2015-1119

15. Antonov A. A. (2016). Physical Reality and Nature of Imaginary, Complex and Hypercomplex Numbers. General Mathematics Notes. 35(2). 40-63.

http://www.geman.in/yahoo_site_admin/assets/docs/4_GMN-10932-V35N2.31895146. pdf

16. Antonov A.A. (2017). The physical reality and essence of imaginary numbers. Norwegian Journal of development of the International Science. 6. 50-63. http://www.njd-iscience.com

17. Antonov A. A. (2024). Physical reality of imaginary numbers and their physi-cal essence. Danish Scientific Journal. 80. 25-35. https://doi.org/10.5281/zenodo.10594282

18. Antonov A. A. (2024). Proof of physical reality of imaginary numbers and explanation of their physical essence. German International Journal of Modern Science. 72. 17-27.

19. Anonov A. A. (2024). Physical reality of imaginary numbers and their physical essence. Sciences of Europe. (Praha, Czech Respublic). 133(1). 79-90. DOI: 10.5281/zenodo.10575590

20. Antonov A. A. (2024). Physical reality of imaginary numbers and their physical essence. The scientific heritage. (Budapest, Hungary). 129. 43-53. DOI: 10.5281/zenodo.10558263

21. Antonov A. A. (2024). Proving Physical Reality and Explaining the Physical Essence of Imaginary Numbers. European Journal of Applied Sciences. Services for Science and Education. UK. 12(2). 362-381. DOI:10.14738/aivp.122.16273

22. Antonov A. A. (2024). Proving Physical Reality and Explaining Physical Essence of Imaginary Numbers. Journal of science. Lyon. 50. 25-35. https://doi.org/10.5281/zenodo.10609816

23. Antonov A. A. (2024). Physical reality of complex numbers and their physical essence. International independent scientific journal. 58. 3-13. https://doi.org/10.5281/zenodo.10491923

24. Antonov A. A. (2024). Proof of physical reality of imaginary numbers and explanation of their physical essence. Annali d'Italia. 51, 25-35. DOI: 10.5281/zenodo.10573831

25. Antonov A.A. (2021). The special theory of relativity stated in physics textbooks is incorrect. 77th International Scientific Conference of the Eurasian Scientific Association "Theoretical and practical issues of modern science". Moscow. ESA. 11-15. (In Russian)

26. Antonov A. A. (2021). Version of the special theory of relativity that is studied in all physics textbooks is incorrect. Österreichisches Multiscience Journal (Insbruck, Austria). 43(1). 17-22. http://osterr-science.com

27. Antonov A. A. (2021). The fallacy of the SRT version studied in physics textbooks proved experimentally. Österreichisches Multiscience Journal (Insbruck, Austria). 45(1). 17-26.

28. Antonov A. A. (2021). Generally accepted version of the special theory of relativity contained in physics textbooks is incorrect. The scientific heritage. (Budapest, Hungary). 73(2). 39-43. DOI: 19.24412/9215-0365-2021-73-2-39-43

29. Antonov A. A. (2021). Special theory of relativity presented in physics text-books is wrong. Norwegian Journal of development of the International Science 68(1). 3-7.

DOI: 10.24412/3453-9875-2021-68-3-7.

30. Antonov A. A. (2021). In all physics textbooks an erroneous version of special theory of relativity is given. International independent scientific journal. 31.34-39.

http://www.iis-journal.com

31. Antonov A. A. (2021). All physics textbooks study incorrect special theory of relativity. Sciences of Europe. (Praha, Czech Republic) 79(1). 30-35. DOI: 10/24412/3162-2364-2021-79-30-35

32. Antonov A. A. (2021). Special theory of relativity, which is studied in physics text-books, is incorrect. German International Journal of Modern Science. 16, 49-53.

DOI: 10.24412/2701-8369-2021-16-49-53

33. Antonov A. A. (2021). Special theory of relativity, which is studied in all physics textbooks, is incorrect. Danish Scientific Journal. 51(1). 31-35. http://www.danish-journal.com

34. Antonov A. A. (2021). Special theory of relativity taught in all physics text-books is incorrect. Annali d'Italia. 22(1). 39-44. https://www.anditalia.com/

35. Antonov A. A. (2021). Special theory of relativity taught in physics textbooks is wrong. Journal of science. Lyon. 23. 47-52. https://www.joslyon.com/

36. Antonov A. A. (2021). Experimental proofs of infidelity of the version of the special theory of relativity studied in physics textbooks and the truth of its alternative version. 80th International Scientific Conference of the Eurasian Scientific Association "Development of science and education in the conditions of world instability". Moscow. ESA. 8-17.

https://esa-conference.ru/sborniki/?y=2021 (In Russian)

37. Antonov A. A. (2021). Experimental evidences for the fallacy of the SRT version in the physics textbooks. European Journal of Applied Sciences. Services for Science and Education. UK. 9(6). 349-364. DOI:10.14738/aivp.96.11304.

38. Antonov A. A. (2021). If the SRT version in physics textbooks were true, we would never have heard the music of the piano and the bell ringing, there would be no television, no cellular telephony, no radar or GPS navigation, we would not even be aware of the existence of resonance and Ohm's law as interpreted by Steinmetz, and our children could not swing on the swings. The scientific heritage (Budapest, Hungary). 78(2). 41-50. DOI: 10.24412/9215-0365-2021-78-2-41-50

39. Antonov A. A. (2021). The SRT version in physics textbooks must be correc-ted, because if it were true, there would be no tsunamis or indian summer in nature, we would be never have heard piano music, engineers would be not have been able to create television, cell phones, GPS trackers, and even children would not be able to swing on swings. Danish Scientific Journal. 54(1). 29-38. http://www.danish-journal.com

40. Antonov A. A. (2021). Experimental refutations of the SRT version contai-ned in physics textbooks and confirmations of the truth of its alternative version. German International Journal of Modern Science. 22. 52-61. DOI: 10.24412/2701-8369-2021-22-52-61

41. Antonov A. A. (2021). Experimental evidence of the incorrectness of the SRT version studied in physics textbooks. Annali d'Italia. 25(1). 32-41. https://www.anditalia.com/

42. Antonov A. A. (2021). The incorrectness of the SRT version presented in physics textbooks proven experimentally. Norwegian Journal of development of the International Science. 74(1). 3-7. DOI: 10.24412/2453-9875-2021-74-53-62.

43. Antonov A. A. (2021). Experimental refutations of the generally accepted version of the SRT studied in physics textbooks. International independent scientific journal. 34(1). 23-32. http://www.iis-journal.com

44. Antonov A. A. (2021). Experimental refutations of the SRT version in the physics textbooks. Journal of science. Lyon. 26(1). 29-37. https://www.joslyon.com/

45. Antonov A. A. (2021). Experimental evidences for the fallacy of the SRT version in phisics textbooks. Sciences of Europe (Praha, Czech Republic). 82(2). 19-28.

DOI: 10.24412/3162-2364-2021-82-2-19-28

46. Antonov A. A. (2021). The version of SRT stated in physics textbooks is incorrect, as it denies the existence of radio engineering. 82nd International Scientific Conference of the Eurasian Scientific Association "Scientific results in theory and practice". Moscow. ESA. 11-15. (In Russian) https://esa-conference.ru/sborniki/?y=2021

47. Antonov A. A. (2022). The version of SRT presented in physics textbooks is incorrect, since it follows from it that radio engineering should not exist. European Journal of Applied Sciences. Services for Science and Education. UK. 10(1). 440-445.

DOI://doi.org/10.14738/aivp.101.2022

48. Antonov A. A. (2022). The existence of radio engineering refutes the physics textbooks' version of SRT. The scientific heritage. (Budapest, Hungary). 83(1). 19-22.

DOI: 10.24412/9215-0365-2022-83-1-19-22

49. Antonov A.A. (2022). The fundamental Ohm's law in radio engineering as interpreted by Steinmetz, which proves the physical reality on imaginary capacitive and inductive reactances, refuted the version of the SRT presented in physics textbooks even before its creation. German International Journal of Modern Science. 26. 50-53. DOI: 10.24412/2701-8369-2022-26-50-63

50. Antonov A.A. (2022). The version of SRT stated in physics textbooks is refuted by the existence of radio engineeng. Danish Scientific Journal. 56. 56-59. http://www.danish-journal.com

51. Antonov A.A. (2022). The version of SRT presented in physics textbooks is incorrect because it denies the possibility of the existence of Ohm's law as interpreted by Steinmetz and, consequently, the existence of radio engineering. Annali d'Italia. 28(1), 43-47.

https://www.anditalia.com/

52. Antonov A.A. (2022). The version of SRT stated in physics textbooks is refuted by the existence of radio engineering. Norwegian Journal of development of the International Science. 78(1). 63-67. DOI: 10.24412/3453-9875-2022-78-63-66.

53. Antonov A.A. (2022). If the physics textbook version of SRT were true, then Ohm's law should not exist in nature, and therefore all radio engineering would not exist. International independent scientific journal. 36. 16-19. http://www.iis-journal.com

54. Antonov A.A. (2022). If the version of SRT in physics textbooks were true, then there would be no radar, no television, no radio navigation, no telecommuni-cation and many other things. Journal of science. Lyon. 28. 76-79. https://www.joslyon.com/

55. Antonov A.A. (2022). The version of SRT set out in physics textbooks is incorrect because it states that Ohm's law as interpreted by Steinmetz does not really exist, and therefore radio engineering does not exist either. Sciences of Europe (Praha, Czech Republic). 87(1). 54-57. DOI: 10.24412/3162-2364-2022-1-54-57

56. Antonov A.A. (2022). The version of SRT set out in physics textbooks is in-correct because it states that Ohm's law as interpreted by Steinmetz does not really exist, and therefore radio engineering does not exist either. Sciences of Europe (Praha, Czech Republic). 87(1). 54-57. DOI: 10.24412/3162-2364-2022-1-54-57

57. Antonov A.A. (2022). Why the physics textbooks teach an incorrect version of the special theory of relativity which denies the existence of radio- and electrical engineering. III international scientific conference "Challenges and problems of modern science." London. Great Britain. 78-86. DOI: https: //doi/org/10.528/zenodo.7486814

58. Steinmetz C. P. (2010). Theory and Calculation of Electric Circuit. Nabu Press. Charlstone.

59. Antonov A. A. (2014). Correction of the special theory of relativity: physical reality and nature of imaginary and complex numbers. American Journal of Scientific and Industrial Research. 5(2). 40-52. doi:10.5251/ajsir.2014.5.2.40.52

60. Antonov A.A. (2023). The Corrected Version of the Special Theory of Relativity. European Journal of Applied Sciences. Services for Science and Education. UK. 11(5). 68-83. DOI:10.14738/aivp.115.15474

61. Antonov A. A. (2023). Corrected special theory of relativity. Annali d'Italia. 49, 25-35.

DOI: 10.5281/zenodo.10214679

62. Antonov A. A. (2023). Special Theory of Relativity. German International Journal of Modern Science. 67. 64-73. DOI: 10.5281/ zenodo.10966458

63. Antonov A. A. (2023). Corrected special theory of relativity. Journal of science. Lyon. 47. 14-23. https://doi.org/10.5281/zenodo.10068983

64. Antonov A. A. (2023). The Corrected Version of the Special Theory of Relativity. The scientific heritage. (Budapest, Hungary). 123. 72-81. DOI: 10.5281/zenodo.10033028

65. Antonov A. A. (2023). The Corrected Version of the Special Theory of Relativity. Norwegian Journal of development of the International Science. 118. 40-49.

https://doi.org/10.5281/zenodo.10009500

66. Antonov A. A. (2023). Alternative Version of the Special Theory of Relativity. Sciences of Europe. (Praha, Czech Republic). 128. 62-71. DOI: 10.5281/zenodo.10081933

67. Antonov A. A. (2023). Corrected Version of the Special Theory of Relativity. Danish Scientific Journal. 77. 88-97. https://doi.org/10.5281/zenodo.10054677

68. Hinshaw G., Larson D., Komatsu E., et al. (2013) Nine Year Wilkinson Anisotropy Probe (WMAP) Observations: Cosmological Parameter Results. arXiv:1213.5226 [astro-ph/CO].

69. Adam R., Ade P.A.R., Aghanim N., et al. (2015). Plank 2015 Results. 1. Overview of Products and Scientific Results. arXiv:1502.01582v2 [astro-ph.CO].

70. Antonov A. A. (2015). Review of publications by A. A. Antonov on the problem of explaining the phenomenon of dark matter and dark energy. Journal of the Russian physic-chemical society. 87(3). 63-76. (In Russian)

71. Antonov A. A. (2015). Hidden Multiverse: explanation of dark matter and dark energy phenomena. International Journal of Physics. 3(2). 84-87. doi:10.12691/ijp-3-2-6

72. Antonov A. A. (2015). Principles and structure of the real Multiverse: explanation of dark matter and dark energy phenomena. American Journal of Modern Physics. 4(1). 1-9.

doi:10.11648/j.ajmp.20150401.11

73. Antonov A. A. (2015). Explanation of dark matter and dark energy phenomena. Journal of Science Frontier Research: A Physics and Space Science. 15(1). 33-38.

74. Antonov A. A. (2016). Explaining the Phenomenon of Dark Matter and Dark Energy by Existence of the Hidden Multiverse. Frontiers of Astronomy, Astrophysics and Cosmology. 2(1). 1-9. doi: 10.12691/faac-2-1-1

75. Antonov A. A. (2016). Hypothesis of the Hidden Multiverse: Explains Dark Matter and Dark Energy. Journal of Modern Physics. 7(10), 1228-1246. doi: 10.4236/jmp.2016.710111

76. Antonov A. A. (2017). Nature of dark matter and dark energy. Journal of Modern Physics. 8(4). 567-582. doi: 10.4236/jmp.2017.84038

77. Antonov A. A. (2017). Hypothesis of the hidden Multiverse explains the phenomenon of dark matter and dark energy. Applied Physics Research. 9(2). 30-41.

doi: https://doi.org/10.5539/apr.v9n2p30

78. Kantor I. L., Solodovnikov A. S. (1989) Hypercomplex Numbers. Springer Verlag, Berlin.

79. Antonov A. A. (2015). Quaternion structure of the hidden Multiverse: explanation of dark matter and dark energy. Global Journal of Science Frontier Research A: Physics and Space Science. 15(8). 8-15.

https://globaljournals.org/GJSFR_Volume15/2-Quaternion-Structure-of-the-Hidden.pdf

80. Antonov A. A. (2020). How to See Invisible Universes. Journal of Modern Physics. 11(05), 593-607. DOI: 10.4236/jmp.2020.115039

81. Antonov A. A. (2020). Universes Being Invisible on Earth outside the Portals Are Visible in Portals. Natural Science. 12(8). 569-587. https://doi.org/10.4236/ns.2020.128044

82. Antonov A. A. (2020). Invisible universes can be seen in anomalous zones. Danish Scientific Journal. 43(1). 9-24. http://www.danish-journal.com

83. Antonov A. A. (2024). Existence of other mutually invisible universes adjacent to our visible universe can be experimentally proven by astronomical observations in the portals of constellations invisible outside the portals. German International Journal of Modern Science. 92. 67-80. DOI: 10.5281/zenodo.14181333

84. Antonov A. A. (2024). Experimental evidence for the existence of other mutually invisible universes neighboring our visible universe. European Journal of Applied Sciences. Services for Science and Education. UK. 12(5). 385-408. DOI:10.14738/aivp.125.17785.

85. Antonov A. A. (2024). Experimentally proved and actually physically existing imaginary numbers as a tool to explain the principle of relativism in SRT. Norwegian Journal of development of the International Science. 144. 69-82. https://doi.org/10.5281/zenodo.14169132

86. Antonov A. A. (2020). Can invisible universes be seen? International independent scientific journal. 21(2). 51-60. http://www.iis-journal.com

87. Antonov A. A. (2020), How to discover invisible universes. Norwegian Journal of development of the International Science. 42(1). 36-48. http://www.njd-iscience.com

88. Antonov A. A. (2024). Proof of the existence of other mutually invisible universes neighboring to our visible universe by astronomical observations in the portals of constellations invisible outside the portals. Sciences of Europe (Praha, Czech Republic). 153. 93-106.

DOI: 10.5281/zenodo.14227583

89. Antonov A. A. (2021). Invisible universes can be seen in anomalous zones. International independent scientific journal. 23(1). 28-44.

90. Antonov A. A. (2024). Proof of the existence of other mutually invisible universes neighboring to our visible universe by astronomical observations in the portals of constellations invisible outside the portals. Annali d'Italia. 61. 43-57. DOI: 10.5281/zenodo.14230824

91. Antonov A. A. (2024). Proof of the existence of other mutually invisible universes neighboring to our visible universe. Danish Scientific Journal. 90. 111-125.

https://doi.org/10.5281/zenodo.14236925

92. Antonov A. A. (2024). Discovery of other constellations in portals that are invisible outside the portals is experimental proof of the existence of mutually invisible universes adjacent to our visible universe. Polish journal of Science. 80. 24-38. DOI: 10.5281/zenodo.14176574

93. Antonov A. A. (2024). It is possible to prove the existence of other mutually invisible universes adjacent to our visible universe by astronomical observations in the portals of constellations that are invisible outside the portals. Slovak international scientific journal (Bratislava, Slovakia). 89. 51-65. DOI: 10.5281/zenodo.14167109

94. Antonov A. A. (2024). Experimentally proved and actually psychically existing imaginary numbers as a tool to explain the principle of relativism in SRT. The scientific heritage (Budapest, Hungary). 149. 50-63. DOI: 10.5281/zenodo.14214530

95. Antonov A. A. (2024). Existence of other mutually invisible universes adjacent to our visible universe can be experimentally proven by astronomical observations in the portals of constellations invisible outside the portals. International independent scientific journal. 67. 29-42. https://doi.org/10.5281/zenodo.14055388

96. Antonov A. A. (2024). Besides our visible universe, there are other invisible universes. Journal of Science. Lyon. 59. 13-26. https://doi.org/10.5281/zenodo.14049575

97. Antonov A. A. (2024). Discovery of constellations in portals that are invisible outside the portals proves the existence of mutually invisible universes adjacent to our visible universe. Sciences of Europe (Praha, Czech Republic). 94. 34- 48. DOI: 10.5281/zenodo.14167218

98. Chernobrov V. (2000). Encyclopaedia of mysterious places of the Earth. Veche Publishing House. Moscow. (In Russian)

99. Chernobrov V. (2004). Encyclopaedia of mysterious places of Russia. Veche Publishing House. Moscow. (In Russian)

100. Chernobrov V. (2007). Encyclopaedia of mysterious places of the Earth and space. Veche Publishing House. Moscow. (In Russian)

101. Chernobrov V. (2009). Encyclopaedia of mysterious places of Moskva and Moscow region. Helios ARV. Moscow. (In Russian)

102. Antonov A. A. (2021). Antimatter, Anti-Space, Anti-Time. Journal of Modern Physics, 12(05), 646-660. DOI: 10.4236/jmp.2021.125042.

103. Antonov A. A. (2021). What is our physical world. 71st International Scientific Conference of the Eurasian Scientific Association. Moscow. ESA. 11-15. (In Russian)

https://esa-conference.ru/sborniki/?y=2021

104. Antonov A. A. Antimatter, anti-space, anti-time. (2021). 75th International Conference of the Eurasian Scientific Association "Strategies for Sustainable Development of World Science". Moscow. ESA. 1-4. DOI: 10.5281/zenodo.4926585 (In Russian)

105. Antonov A. A. (2021). Do antimatter, anti-time and anti-space exist in nature. Annali d'Italia. 20(1). 14-24. https://www.anditalia.com/

106. Antonov A. A. (2021). From the alternative version of the SRT it follows that there is not only antimatter, but also anti-space and anti-time. Norwegian Journal of Development of the International Science. 62(1). 41-51. DOI: 10.24412/3453-9875-2021-62-1-41-51

107. Antonov A. A. (2021). Antipodes in space. German International Journal of Modern Science. 11(1). 15-25. DOI: 10.24412/2701-8369-2021-11-1-15-25

108. Antonov A. A. (2021). There is not only antimatter, but also anti-space and anti-time. Journal of science. Lyon. 21. 22-30. https://www.joslyon.com/

109. Antonov A. A. (2021). Where are antimatter, anti-space and anti-time? Österreichisches Multiscience Journal. (Insbruck, Austria). 40(1). 34-44. http://osterr-science.com

110. Antonov A. A. (2021). Do antmatter, anti-time and anti-space exist in nature? Danish Scientific Journal. 48(1). 64-74. http://www.danish-journal.com

111. Antonov A. A. (2021). Antipodes in space. International independent scientific journal. 28. 50-61. http://www.iis-journal.com

112. Antonov A. A. (2021). How alternative version of SRT explains the existence of antimatter, anti-space and anti-time? The scientific heritage (Budapest, Hungary). 67(1). 11-21. DOI: 10.24412/9215-0365-2021-67-1-11-21

113. Antonov A. A. (2025). Time Travels are Already Possible Nowadays. European Journal of Applied Sciences. Services for science and education. U.K. 13(03). 47-70.

DOI:10.14738/aivp.1303.18764.

114. Antonov A. A. (2025). Time travels are already possible for people on Earth. German International Journal of Modern Science. 104. 64-76. DOI: 10.5281/zenodo.15480577

115. Antonov A. A. (2025). Discovery of the possibility for people on Earth of time travels. Norwegian Journal of development of the International Science. 156. 84-98.

https://doi.org/10.5281/zenodo.15397809

116. Antonov A. A. (2025). The discovery of physically real time travels. Journal of Science. Lyon. 66. 33- 48. https://doi.org/10.5281/zenodo.15584655

117. Antonov A. A. (2025). The physical reality of time travels available to people. Annali d'Italia. 67. 58-72. DOI: 10.5281/zenodo.15545211

118. Antonov A. A. (2025). The physical possibility for people on Earth of time travel. The scientific heritage. 163. 44-58. DOI: 10.5281/zenodo.15728017

119. Antonov A. A. (2025). Proof of the physical reality of time travels available to humans. Danish Scientific Journal. 96. 72-86. https://doi.org/10.5281/zenodo.15553087

120. Antonov A. A. Time travels is now physically possible. XX international scientific conference "The modern vector of the development of science". Philadelphia. USA. 12-13.06.2025.

121. Antonov A. A. (2025). The physical possibility for people on Earth of time travels. Polish journal of Science. 87. 39-53.

122. Antonov A. A. Time travels is now physically possible. XVI international scientific conference "Theoretical and practical perspectives of modern science". Stockholm. Sveden. 27-28.05.2025.

123. Antonov A. A. The discovery of physical possibility of time travels. II International Scientific Conference "Expanding knowledge through interdisciplinary research". Sydney. Australia. 15-16.05.2025.

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